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DETERMINING THE OPTIMAL OPERATIONAL CONCEPT IN THE ORTHOPEDIC CLINIC USING SIMULATION

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MAJOR WILLIAM B. GRIMES
BLANCHFIELD ARMY COMMUNITY HOSPITAL

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MAJ WILLIAM B. GRIMES, MS

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The total time a patient spends in an Orthopedic Clinic was studied using computer simulation. Patient arrival patterns, patient flow patterns, and time distributions were developed and the data was entered into a computer simulation program. Results of the simulation yielded insights into clinic dynamics. Proposed operational changes should significantly decrease the average patient total time in clinic from 74.54 (SD 16.32) minutes to 51.42 (SD 15.63) minutes, ($p<.001$, t test).

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Table of Contents

Chapter 1

Introduction. 8

Conditions Which Prompted the Study. 14

Problem Statement. 14

Literature Review. 15

Purpose. 26

Chapter 2

Method and Procedures 27

Data Collection. 38

Validity of the Model. 41

Assumptions. 43

Limitations. 43

Ethical Considerations. 44

Chapter 3

Results. 45

Chapter 4

Discussion. 48

Chapter 5

Conclusion and Recommendations. 62

Appendix A-F Orthopedic patient flowcharts

Appendix G Orthopedic surgeon appointment templates

Appendix H Orthopedic physician assistant appointment templates

Appendix I Quality service survey

Appendix J-M Orthopedic Clinic floor plans

Appendix N Simulation scenarios

Appendix O Subjective validation of the base model

Appendix P ANOVA results

Appendix Q Orthopedic Clinic emergency room referrals scheduling sheet

Appendix R Architectural blueprints of central reception/business office

Appendix S Revised templates

Appendix T Presentation to the hospital commander and staff

List of Tables

Table 1. Orthopedic surgeon clinical appointment backlog 10

Table 2. Variables determining optimal clinical operational concept 29

Table 3. Simulation project timeline. 30

Table 4. Number of Orthopedic Clinic visits by patient appointment type. 34

Table 5. Orthopedic Clinic provider workload. 37

Table 6. Sample sizes 40

Table 7. Clinic operating hours and assigned shift numbers 41

Table 8. Results of simulation (variables 1-5) 46

Table 9. Results of simulation (variables 6-10) 47

Table 10. Orthopedic surgeon efficiency. 54

Table 11. Related major unit training exercises.. 57

Table 12. ADD/NADD TRICARE Prime Orthopedic Clinic utilization rates among like-sized facilities 59

Table 13. Predicted ADD/NADD TRICARE Prime Orthopedic Clinic utilization rates. 60

List of Figures

Figure 1. BACH's direct care eligible beneficiaries 8

Figure 2. Orthopedic injuries and running 9

Figure 3. Orthopedic clinic beneficiaries 11

Figure 4. Classical decision making methodology 16

Figure 5. Decision making methodology involving simulation. 17

Figure 6. Lifecycle of a simulation project 20

Figure 7. Comparison of appointment systems. 32

Figure 8. Total patient appointment type arrival patterns 35

Figure 9. Patient arrival patterns by appointment type 35

Figure 10. Orthopedic Clinic workload and significant events 53

Figure 11. Calendar year 1997 no-show rates for the Orthopedic Clinic 56

Figure 12. The number of patients the Orthopedic Clinic was scheduled to see. .58

Figure 13. 1997 Orthopedic Clinic visits compared to predicted requirements . .61

Abstract

The total time a patient spends in an Orthopedic Clinic was studied using computer simulation. Patient arrival patterns, patient flow patterns, and time distributions were developed and the data was entered into a computer simulation program. Results of the simulation yielded insights into clinic dynamics. Proposed operational changes should significantly decrease the average patient total time in clinic from 74.54 (SD 16.32) minutes to 51.42 (SD 15.63) minutes, ($p<.001$, t test).

CHAPTER 1

Introduction

Blanchfield Army Community Hospital (BACH) is located at Fort Campbell, Kentucky and is the only military hospital named for a Nurse Corps Officer, COL Florence E. Blanchfield. The hospital currently operates 106 beds, maintains an average inpatient census of 35, and averages 2,000 outpatient visits a day (M. Arrington, personal conversation, 14 October 1997). According to July 1997 Defense Enrollment Eligibility Reporting System (DEERS) enrollment data, there are 79,828 direct care eligible beneficiaries in BACH's catchment area (see Figure 1).

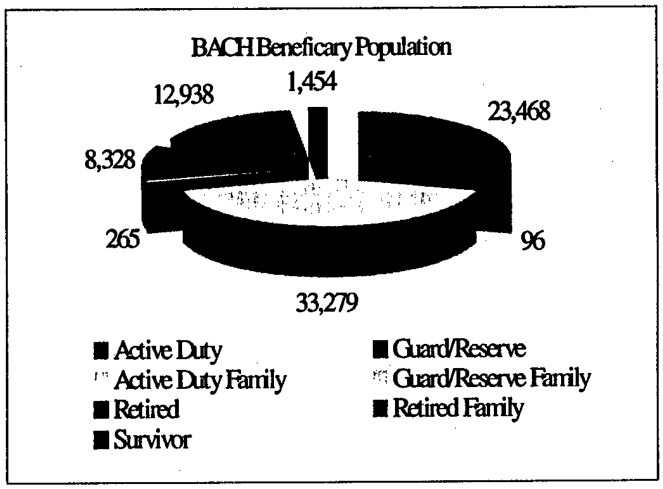

Figure 1. BACH's direct care eligible beneficiaries.

and distinguish

The primary active duty beneficiary population consists of soldiers assigned to the 101st Airborne Division (Air Assault), 5th Special Forces Group, 160th Special Operations Aviation Regiment (SOAR), and supporting organizations (P. Williams, personal conversation, 15 October 1997). This population is unique because the soldiers assigned to these military units are considered by many in the armed forces to be elite and often participate in physically challenging training, which expectantly results in an high incidence of orthopedic injuries.

Another factor contributing to the high incidence of orthopedic injuries is that soldiers assigned to units at Fort Campbell routinely run over twelve miles a week (B. Buckley, personal conversation, 15 October 1997). To substantiate the link between running and orthopedic injuries, a study evaluating orthopedic injuries among soldiers assigned to Fort Campbell was conducted at Fort Campbell in the summer of 1995. In the study, a sample of 200 soldiers who routinely ran twelve miles and over were compared to those who routinely ran less than twelve miles. The results of the study indicated a 46% greater incidence of orthopedic injuries among those who routinely ran over twelve miles a week. The study was repeated in January 1996 with a smaller sample size (n=62) with similar results (see Figure 2).

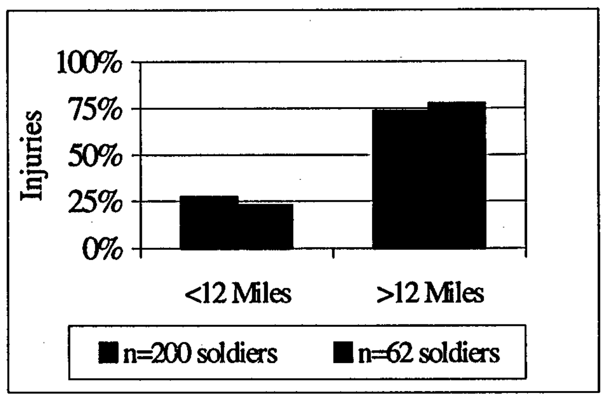

Figure 2. Orthopedic injuries and running.

Primarily because of the demanding active duty workload, the Orthopedic Clinic at BACH remains busy and most of the providers have accumulated extensive patient backlogs (see Table 1).

Table 1

Orthopedic Surgeon Clinical Appointment Backlog

Provider	Clinic Appointment Backlog	Number of Patients
Orthopedic Surgeon 1	6 weeks	161
Orthopedic Surgeon 2	4 weeks	148
Orthopedic Surgeon 3	5 weeks	103
Orthopedic Surgeon 4	2 weeks	42
Orthopedic Surgeon 5	1 week	27
Orthopedic Surgeon 6	1 week	22

Note. The source for the data was CHCS, clinic code BEAA.

There are two types of patient backlogs: surgical backlog and schedule backlog. Currently, the surgical backlog consists of patients electing to remain on the waiting list for personal reasons. An example of this is a soldier whose wife is pregnant and postpones his surgical procedure until after the birth of the child (D. Miles, personal conversation, 14 October 1997). Schedule backlog is defined as the inability to schedule a patient appointment within TRICARE Prime access standards. TRICARE Prime access standards for patient appointments to specialty clinics are: (a) within four weeks for a routine consult; (b) within 72 hours for a 72 hour consult; (c) the same day for a today or emergency consult; and (d) thirty minute waiting times for appointments. Failure to meet access standards results in the both active duty and non-active duty patients being sent to a medical facility in the TRICARE network which can meet the standards. When this happens for non-active duty patients, the patient incurs a nominal fee and the military treatment facility (MTF) pays the remaining cost of the visit. For active duty patients, failure to meet access standards results in a referral and BACH is responsible to pay the entire bill for the episode of care (supplemental care) [Memorandum for Access Standards, ASD(HA) 1997].

Access to the Orthopedic Clinic is a problem for other than active duty beneficiaries. According to data from the Ambulatory Data System (ADS), in the last twelve months (Jan 97-Dec 97) 10,888 of the 14,955 or 72.8% of the Orthopedic Clinic's workload was active duty beneficiaries (see Figure 3). The majority of the remaining 27.2% of the orthopedic visits consisted primarily of other than active duty beneficiaries first seen in the hospital's Emergency Center (EC) and then referred to the Orthopedic Clinic.

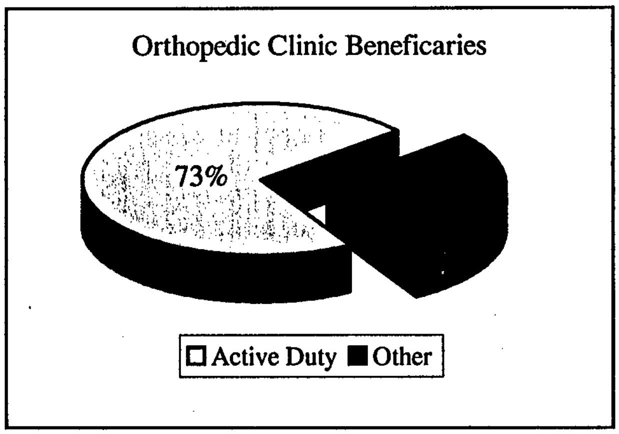

Figure 3. Orthopedic Clinic beneficiaries.

According to the clinic chief, a typical example of an EC referral occurs when a dependent receives an orthopedic injury, is seen in the emergency room, and then is told to "walk-in" to the Orthopedic Clinic for further treatment (S. Larson, personal conversation, 18 October 1997). Regardless of beneficiary status, once a patient is seen by a provider in the Orthopedic Clinic, the patient continues to receive treatment until the episode of orthopedic care is completed and the patient is referred to the primary care manager (PCM).

Studies to determine ways to improve efficiency and beneficiary access in the Orthopedic Clinic have been conducted before. In August 1995, a Managed Care Division staff member conducted an extensive review of clinic operations. Some of the problems noted were: (a) recent personnel turnover in the Orthopedic Clinic; (b) choke points in patient movement at the reception and screener desks; and (c) orthopedic surgeons having to conduct time-consuming Medical Evaluation Boards (MEBs) (M. Arrington, personal conversation, 15 October 1997). Recommendations resulting from the study included: (a) developing clinical pathways for high volume conditions; (b) developing treatment plans for returning patients to primary care for chronic non-surgical conditions; (c) decreasing the appointment to walk-in ratio; (d) providing each provider with two exam rooms each clinic day; (e) reducing the number of MEBs conducted by orthopedic surgeons; and (f) relocating the clinic's reception desk. Unfortunately, the changes were never fully implemented (M. Arrington, personal conversation, 15 October 1997).

Although the clinic is at full authorized staffing (six orthopedic surgeons, one podiatrist, two orthopedic physician assistants, one podiatry technician, seven orthopedic technicians, and four clerks) as of October 1997, most of the problems noted in the August 1995 study remain. Because of the approaching TRICARE standards for patient care, recommendations to solve these problems must be convincingly presented to the clinic's leadership and then implemented.

TRICARE

TRICARE is the Department of Defense's managed care initiative. The TRICARE program separates the continental United States into twelve regions. In each region, the commander of a large medical facility is designated as the lead agent and is responsible to implement the program in it region. Civilian contractors augment the provision of health care. BACH is located in Region Five and Wright Patterson Air Force Base is designated as the lead agent. Although the contract has not been finalized, Anthem Alliance Health Insurance (AAHI) has been designated as the civilian contractor to augment the provision of health care in Region Five.

TRICARE is scheduled to begin at Fort Campbell on 1 May 1998. The ultimate success of the TRICARE program depends on enrollment of the beneficiary population (T. Edman, personal conservation, 9 February 1998). They can enroll in one of four options: (a) TRICARE Prime at BACH, (b) TRICARE Prime with the contractor (AAHI), TRICARE Extra, and TRICARE Standard. TRICARE Prime is the only option that gives enrolled beneficiaries guaranteed access standards. Failure to meet these standards results in referrals to the TRICARE network of providers and monetary loss to BACH. BACH's CHAMPUS eligible beneficiary population is approximately 79,000 and Anthem

Alliance Health Insurance (AAHI) predicts total enrollment for TRICARE Prime at BACH to be 54,990.

Conditions Which Prompted the Study

The conditions which prompted the study include: (a) the requirement to meet TRICARE standards for access to specialty appointments (4 weeks) and in-clinic appointment wait time (30 minutes); (b) the perception that the Orthopedic Clinic is inefficient; (c) the perception the current patient appointment system is ineffective; (d) the extensive patient waiting list (backlog) for follow-up visits with certain providers; (e) resource protection under TRICARE; and (f) the desire to validate the advantages of a potential clinic structural redesign.

Statement of the Problem

While the Orthopedic Clinic's perceived inefficiency is a problem, the primary problem is that there is no effective and convincing method of comparing alternative approaches to improving efficiency in the Orthopedic Clinic at BACH. Several ideas such as changing the patient arrival patterns and changing the location of the treatment rooms have been discussed but remain stagnant because of the difficulty of convincing the clinical leadership and staff the changes will produce meaningful results. An example of this is the previous mentioned efficiency study of the clinic conducted in August 1995. This study accurately determined the clinic's inefficiencies and provided sound recommendations but evidently did not present them in a convincing manner because the clinic's leadership implemented only some of the recommendations (M. Arrington, personal conversation, 16 October 1997). In addition, BACH is considering a $50,000 renovation project in the Orthopedic Clinic designed to ease congestion at the reception desk and improve overall patient flow in the clinic (See Appendix K). On the surface, the renovations may seem like a worthy endeavor, but there currently is no method of determining or predicting whether the cost incurred in the modifications will actually result in improved clinic efficiency.

Literature Review

The literature review is separated into two parts. The first part of the literature review is used to document the use of computer simulation as a management and reengineering tool. The second part of the literature review identifies key elements in improving clinic efficiency and provides the basis for altering certain aspects of clinic operations in the various simulation scenarios used in the study.

What is Computer Simulation?

[Benneyan (1992) and Dawson et al., (1994)], define simulation as an analytical tool that models or simulates the operation of an actual process of a real-life system over time. Computer simulation is a widely used operations research tool and is one of several methods used to improve processes. Simulation allows for the evaluation of alternatives before processes become permanent and is one of the most innovative, cost effective and rewarding ideas in recent times (Keller et al., 1991). Simulation's advantages as an evaluation method are its ability to offer a less expensive, less disruptive, and more expeditious method of comparing alternatives (Benneyan, 1992). Recent advances in computer technology have made computer-based simulation more effective with simulation software and specific consulting services targeted towards the healthcare market (Benneyan, 1992).

Advantages of computer simulation

Ditch and Hendersott (1997) considered the classical decision making methodology healthcare managers currently use to make operational decisions as being not much better than a scientific guess (see Figure 4). They note the

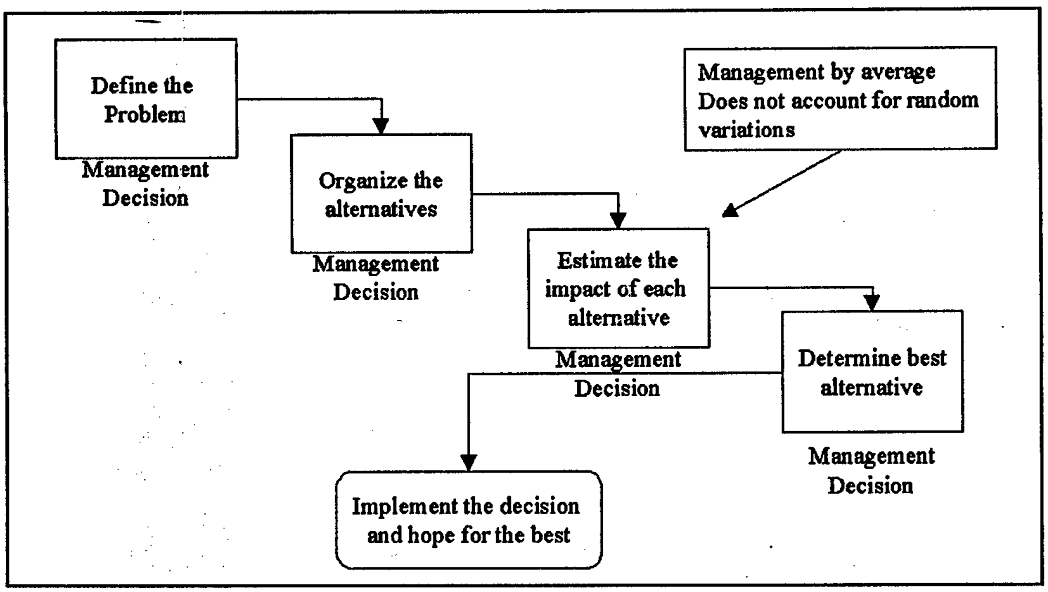

Figure 4. Classical decision making methodology.

greatest limitation in this process is that variance is not accurately accounted for and the manager must make an educated guess at the impact of the proposed alternatives.

Figure 5 depicts the decision-making methodology involving the use of simulation. The significant advantage of this methodology is that by using distributions instead of averages variance in the process is considered. By considering variance, the projected impact of a decision or course of action makes on the organization can be more accurately predicted.

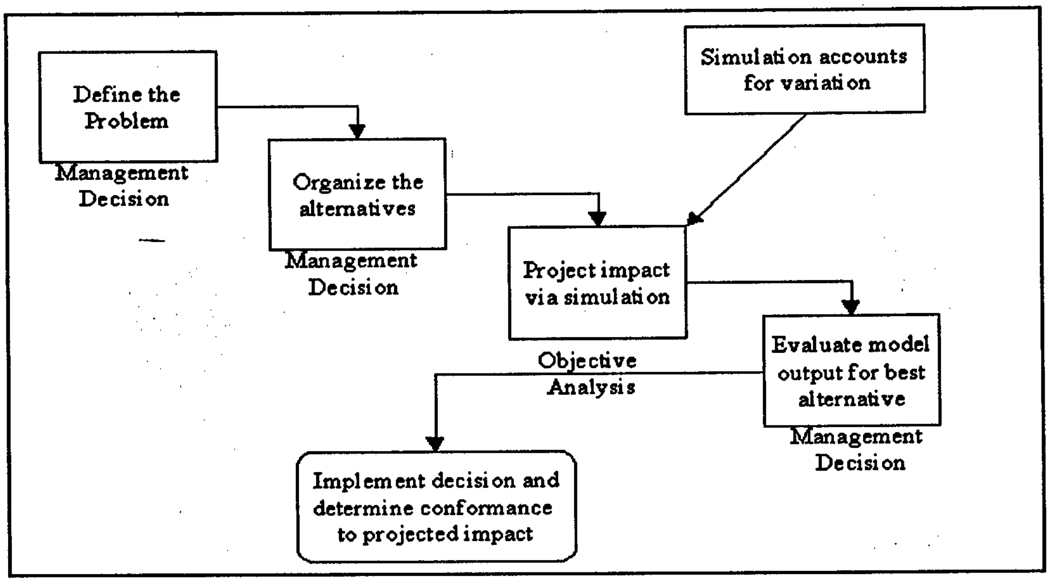

Figure 5. Decision making methodology involving simulation.

Computer simulation in healthcare

Although computer simulation has been used to improve efficiency in the provision of healthcare as early as 1962, its popularity has recently increased (Hendershott, 1995). This is evidenced by the increase in articles about healthcare simulation from just over 200 published by 1975 to over 427 simulation articles published by 1981 (Benneyan, 1992). In addition, simulation has been used increasingly for modeling complex systems, including multiple hospital units with capacity constraints that defy mathematical analysis (Lowery and Martin, 1992).

Some [Lowery (1994), McGuire (1997), and Kellar (1997)] believe that the current healthcare environment is ripe for simulation. A growing number of hospitals are using healthcare specific simulation technology to help identify process improvements, particularly when there are a number or alternatives under consideration (McGuire, 1997). The pressure to control costs is creating a need for powerful tools to analyze current procedures and conduct inexpensive, undisruptive "what-if" analysis (Lowery, 1996).

<u>Problems with simulation</u>

Lowery (1996) notes that although the use of simulation of healthcare is increasing in popularity, it is a difficult process. Some of the problems or difficulties include: (a) healthcare manager's traditional reliance on simpler, deterministic analytic techniques for decision making; (b) administrators and providers' resistance to the unfamiliar and dehumanizing nature of simulation; (c) the highly technical nature of simulation; and (d) the complexity of the provision of healthcare services (Lowery, 1996). Simulation projects fail for three reasons: (a) poor salesmanship; (b) the lack of education among clients about simulation; and (c) the extended amount of time required to complete a simulation project (Kellar et al., 1997).

How to simulate

Simulation should be conducted in four phases (Benneyan et al., 1994). In the first phase the problem is identified, objectives are clarified, and the project timeline/milestones are established. The most significant aspect of the first phase is clarification of the objectives. According to Benneyan et al., (1994), many simulation projects end up being meaningless because the objectives of the study were not clear from the start of the project. In phase two the actual simulation model is completed. Once completed, the model is validated by comparing the simulation results with actual data. Phase three consists of experimentation with the different scenarios or designs. In phase four the results of the simulated scenarios are presented and implemented if no further analysis is required (see Figure 6).

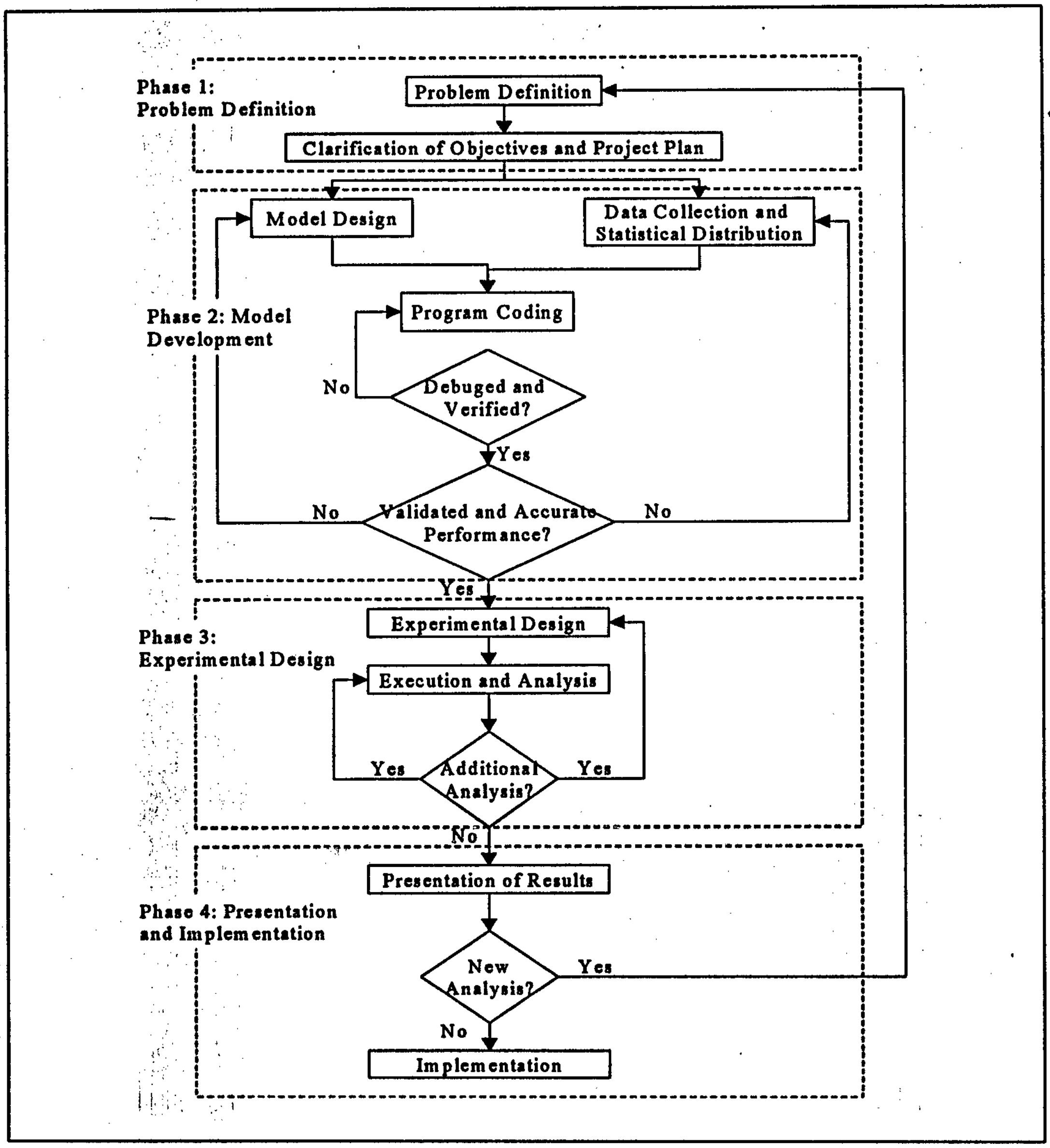

Figure 6. Lifecycle of a simulation project.

Staffing ratios

There are many studies related to staffing ratios that used computer health care simulation software. In particular, there are three studies [Allen et al., (1997), Dawson et al., (1994), and Kirtland et al., (1995)] that found simulation to be an effective tool in determining health care staffing ratios. Some proponents of using simulation to determine staffing ratios believe that simulation is superior to traditional staffing analysis techniques because it takes into account the dynamic nature of what is being studied (Dawson et al., 1994). Another advantage is that simulation allows the facility to create and evaluate various staffing ratio scenarios without a great investment in time or money.

Computer modeling and simulation was used to determine the optimal staffing ratio for a family practice clinic (Allen et al., 1997). After determining four potential scenarios involving different ratios of providers and support staff, they simulated each scenario and determined the most efficient staffing mix. In addition, the simulation determined: (a) the optimal patient service representative staffing level at the front desk; (b) the optimal level of medical assistants when the medical assistant was assigned to an individual primary care provider; (c) the optimal level of medical assistants when the medical assistant being assigned to a pool and could be assigned to any primary care provider; and (d) the impact of different patient scheduling practices on clinic and personnel utilization (Allen et al., 1997).

Simulation was also used to determine the appropriate staffing ratio of an emergency room (Kirtland et al., 1995). The goals of the simulation were to improve the operation of the emergency room and reduce patient throughput times by properly determining appropriate staffing levels. The evaluation team examined eleven different staffing ratio alternatives and used simulation to determine the most efficient staffing ratio. After completing the simulation, the evaluation team stated that using simulation as an analysis tool proved to be an effective method to test and evaluate alternatives before implementing changes (Kirtland et al., 1995).

Wilt & Goddin (1989) used simulation to determine the staffing requirements and optimal equipment placement in a proposed outpatient diagnostic center in the Osteopathic Medical Center of Philadelphia. While the floor plan design was believed to be innovative and effective, the medical center's staff wanted to test both the equipment (X-ray, CAT scan and mammography equipment, etc.) locations and staffing (clerical staff, technicians, phlebotomists, radiologists, and physician) combinations prior to actual construction. The results of the study indicated an optimal staffing ratio and recommended changes to the proposed floor plan to accommodate more efficient equipment location.

Using computer simulation, Dawson et al., (1994) conducted a staffing level study for St. Joseph Hospital and Medical Center, a 607 bed acute care facility located in Detroit, Michigan. The purpose of the detailed (the simulation included the use of flexible staffing and staggered shifts) simulation was to determine the best nurse and technician staffing level for the emergency center. After developing flow charts and using a triangular distribution for patient arrivals, the evaluation team used simulation to evaluate various nurse and technician staffing combinations. Using the results of the simulation as an aide, the evaluation team was successful in persuading the hospital's chief executive officer (CEO) to accept their recommendation.

Now that we have defined computer based simulation and discussed its advantages and disadvantages, we will explore why we are altering certain aspects of the clinic in an attempt to improve clinic efficiency. Several literature sources discussed below conclude that the optimization of essential clinic activities, such as patient flow and the patient appointment systems, is vital to improving efficiency.

Determining clinic efficiency

Before we can explore ways to improve efficiency in a clinic it is necessary to first define efficiency and then describe how it can be measured in the provision of health care. Efficiency was defined by McKeon (1996), as the elimination of all activities and costs that do not produce value to the consumer. He further states that efficiency can be accomplished by: (a) examining internal processes and eliminating those that do not produce value; (b) enhancing those processes that add value; and (c) investing in technology (McKeon, 1996). While McKeon's definition is clear, applying it to the multiple processes in a health clinic is not as simple as it sounds because of the many confounding variables involved. A more applicable study on clinic efficiency was conducted by Lanto et al., (1995) and they concluded that clinic efficiency could best be determined by documenting and analyzing the time essential clinic activities require. Analyzing these events can assist managers to improve clinic procedures, staff utilization, and overall efficiency (Lanto et al., 1995).

Clinic efficiency and patient satisfaction are closely linked. Inefficient clinic operation usually creates excessive waiting times for patients and can be one of the most common sources of patient dissatisfaction (Hermida et al., 1996). Clinic waiting times have long been a source of patient complaints and dissatisfaction (Lanto et al., 1995).

Patient flow

Determining the most efficient patient flow through an outpatient clinic is vital to the optimization of the clinic's resources and patient satisfaction (Hermida et al., 1996). Implementing both Lanto and McKeon's concepts on efficiency, it is necessary to first define the current clinic patient flow and then determine the optimal patient flow. The identification and elimination of those activities that do not produce value is vital to improving efficiency. Similarly, activities contributing to the creation of patient clustering or "bottlenecks" must be eliminated. In a study of a general practice clinic conducted by Hermida et al., (1996), the majority of patient waiting time was created by bottlenecks at the reception and clerical areas of the clinic, not waiting for treatment by a health care professional. Hermida et al., (1996), concluded that once a bottleneck is created it has a dramatically adverse effect on patient flow. To facilitate patient flow through a clinic, Hermida recommended pre-registering patients scheduled to return to the clinic. In a similar study conducted by Minden (1994), he recommended stationing an ambassador to inform patients of the reason for their delay and giving patients scheduled to return to the clinic business cards with their appointment time and date and other clinic information. Minden found that an added benefit of informing patients of the reason for their wait was that it also helped the staff identify the creation of a clinic bottleneck before it became a problem (Minden, 1994).

Patient appointment systems

Worthington and Brahimi (1993) conducted an efficiency study of a multi-functional clinic and concluded that the appointment system is the most important item when considering clinic efficiency because it determines the pattern of patient arrival to the clinic (Worthington and Brahimi, 1993). Worthington and Brahimi (1993) found that if the appointment system is inappropriate or is adversely effected by a high incidence of unscheduled patients, it could create long patient waiting times and increased inefficiency. Their study also concluded that: (a) physician lateness can be a serious issue; (b) patient lateness leads to decreased waiting times but increases the idleness of the physicians; (c) clinic efficiency is sensitive to the level of physician interruptions; and (d) patients with long consultation times are a source of congestion.

Huarng and Lee (1996) conducted a study of an outpatient clinic's appointment systems and attempted to improve it using computer simulation. In their study, they found that the average consultation time and the punctuality of the patient are the two main factors in determining the scheduling system for an outpatient facility and the most pronounced improvements occurred when the patient arrival patterns were level (Huarng and Lee, 1996).

Schuhart (1994) developed a new patient appointment system called the modified wave. The modified wave concept involves having patients of various appointment types arrive to the clinic in clusters (Schuhart, 1994). For example, three patients arrive at 0830, two arrive at 0845 and one at 0900. This cycle repeats throughout the scheduled day. The concept of the modified wave appointment system is to keep a flow of patients available for the providers.

Purpose

The purpose of this study is to improve Orthopedic Clinic operations by determining the optimal operational concept using simulation. The simulation scenario that produces the greatest number of patients seen in the least time in the clinic for the patients and maximum utilization of the staff will determine the most efficient operational concept. For the study to be considered successful, the Orthopedic Clinic's leadership must implement the recommendations.

CHAPTER 2

Method and Procedures

Several literature sources [MedModel Instruction Manual (1994), Benneyan et al., (1994), Benneyan (1997), and Lowrey (1996)] similarly defined the method of conducting a simulation study as: (a) plan the study, (b) define the objectives, (c) identify constraints, (d) develop the budget and schedule, (e) define the system, (f) build the model, (g) run experiments, (h) analyze output, and (i) report results. The researcher conducted the study using this methodology. It should be noted that hypothesis testing will not be used as a methodology because the simulation model is only an approximation of an actual system. The null hypotheses that model behavior and system behavior are the same will almost certainly be false making hypothesis testing ineffective [Lowrey, (1996) and Law and Kelton, (1991)].

Plan the study

Phase I.

Phase I consisted of data collection, information gathering and objective determination. The researcher conducted interviews with the current Orthopedic Clinic's leadership and staff. Current problems, potential solutions, past efforts and recent initiatives were discussed and incorporated in the modeling scenarios. In coordination with the Orthopedic Clinic's staff, the researcher established a timeline of significant events and briefed the hospital command.

Phase II.

In Phase II, the base model and the scenarios were constructed and the processing logic was completed.

Phase III.

In Phase III, the optimal organizational concept for the Orthopedic Clinic was determined. This was accomplished by first measuring the variables in Table 2 generated by a sample of actual patients seen in the clinic, conducting changes via scenario simulation, and then re-measuring the same variables. The results were objectively compared to determine which scenario produces the most expeditious processing of patients through the clinic.

Table 2

Variables determining optimal clinical operational concept

Variables in the study	Measurement
1. Average minutes in system (All patient types combined)	Minutes
2. Average minutes waiting for resources (x-ray, surgeons, receptionists, physician assistants, etc.)	Minutes
3. Average minutes in operation (In contact with providers or clinic staff)	Minutes
4. Clinic simulation time (Total time required to treat all patients)	Minutes
5. Number of patients seen	Number
6. Orthopedic surgeon utilization	Percentage
7. Orthopedic PA utilization	Percentage
8. X-ray technician utilization	Percentage
9. Orthopedic technician utilization	Percentage
10. Orthopedic clerk utilization	Percentage

Note. One year's worth (250 repetitions) of simulation will be conducted with each scenario.

Define objectives

The objectives of the study are to: minimize patient time in system, thereby optimizing the number of patients seen; and maximize provider and staff utilization. Obtaining these objectives meets the overall purpose of the study, which is to determine the optimal operational concept for the Orthopedic Clinic.

Identify constraints

There are two constraints applicable to this study: money and staffing levels. It is unrealistic to assume BACH has unlimited funds to reorganize the clinic and it is equally unrealistic to simulate scenarios with unlimited staffing levels.

Develop a budget and schedule

Developing a budget was not applicable to this study. A timeline for the study was completed and briefed to both the hospital and clinic leadership (see Table 3).

Table 3

Simulation Project Timeline

Activity	Timeline
Document and define the existing system	15 Aug 97-15 Sep 97
Data Collection	15 Sep 97-31 Oct 97
Model building	1-15 Nov 1997
Validate the model	15-31 Nov 1997
Perform the simulation	1-31 December 1997.
Interpret the results	1-31 January 1998

Define the system

Functional layout of the clinical space.

The Orthopedic Clinic consists of eighteen treatment rooms, two x-ray rooms, one cast (fracture) room with five treatment tables, eleven surgeon/staff offices, one staff lounge with facilities, one reception desk with area for two receptionists, one screening table with room for two screeners, one room for an appointment clerk and schedule coordinator, and a 50 chair waiting room. Twenty chairs are located outside the cast room and provider offices where space permits (see Appendices J and M). From a functional standpoint, the clinic's main architectural limitation is the main entrance and the location of the reception desk. The reception desk is located close to the entrance; while this location provides the staff the ability to control access to the clinic, it creates congestion among patients attempting to check-in and others accessing the clinic. Patients on crutches, in plaster casts, and wheelchairs further aggravate the problem. The rest of the clinic appears to be well organized with adequate space for the providers and storage.

Appointment system.

There are two methods by which patients can gain access to the Orthopedic Clinic: scheduled appointments, which are acquired through the CHCS appointment system and the Orthopedic Clinic appointment clerk or receptionist, and unscheduled appointments (walk-ins), usually resulting from a referral from the emergency room or an orthopedic surgeon's instruction to return to the clinic as a "walk-in" at some later date (see Figure 7). The majority of patients that walk in are sent to the cast room to be evaluated by an orthopedic physician assistant prior to seeing a physician (S. Larson, personal conversation, 17 October 1997).

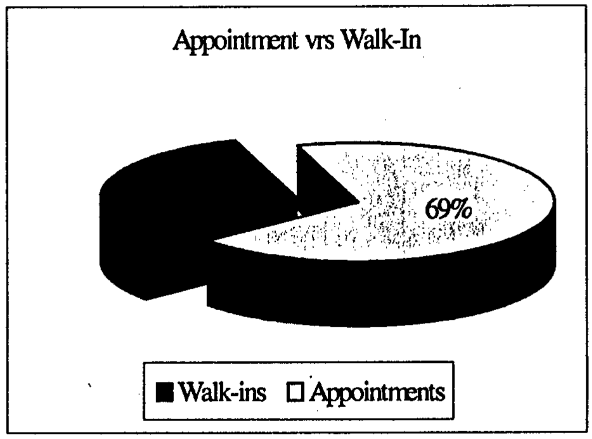

Figure 7. Comparison of appointment systems.

Operating hours.

The clinic opens at 0730 and remains open until all patients have exited (usually around 1700). Patients are scheduled for appointments from 0730 to 1630 hours. Although there are no patients scheduled during the lunch hour (1130-1230), the clinic is not closed, and patients continue to be treated.

Current clinic staffing.

The organizational staffing of the Orthopedic Clinic consists of six orthopedic surgeons (including the clinic chief), one podiatrist, two orthopedic physician assistants, one podiatry technician, one x-ray technician, seven orthopedic technicians [including the NonCommissioned Officer in Charge (NCOIC)], and four administrative personnel.

Patient types.

The researcher used the Composite Health Computer System (CHCS) appointment template patient types in use by the Orthopedic Clinic to accumulate patient data for the simulation model. There are eight types of appointments and each type is a separate entity in the model. Creating separate entities allowed for a more accurate replication of how each patient type processed through the clinic, where they waited, and how long they waited or were delayed. Flowcharts depicting patient movement through the clinic were constructed for each patient appointment type (see Appendices A-F). Listed below are the appointment type and brief definitions.

Consult (CON) - Consults can be 72 hour, routine, today, and emergency. Each type of consult has a different routing through the clinic. Routine consults are patients referred from another physician assistant at the troop medical clinic. Consults are scheduled for 30 minutes on provider appointment templates.

Follow-up (FOL) - Follow-ups are patients who have been seen by the provider previously. For varying reasons, the physician wants to see the patient again. Follow-ups are scheduled for 20 minutes on provider appointment templates.

Inpatient (INP) - Pre-operatory visit with the physician who will perform the surgery. Scheduled for 45 minutes on provider appointment templates.

Medical Evaluation Board (MEB) - The physician evaluates a patient's physical disability for disability classification purposes. MEB's are scheduled for 60 minutes on provider appointment templates.

New (NEW) - New patient to the clinic. New patients to the Orthopedic Clinic and are seen by physicians only. New patients are referred by another physician and are candidates for orthopedic surgery. New patients are scheduled for 30 minutes on provider appointment templates.

Physicals (PHY) - Patients are evaluated for continuance on the Temporary Disability Retiree List (TDRL). PHY's are scheduled for 60 minutes on provider appointment templates.

Post-operative (POP) - Post-operatory visit with the physician who performed the surgery. Post-operative appointments are scheduled for 15 minutes on provider appointment templates.

Special (SPC) - Only physicians can use this appointment template for special cases. SPC's are scheduled for 15 minutes on provider appointment templates

Clinical workload data.

Historical data determining patient arrival patterns and the number of clinic visits by patient appointment types was collected for a three month period (1 Oct 97-31 Dec 97). The primary source for the data was the CHCS and ADS systems. The data was provided and verified by the hospital's Outcome Management Division (OMD). The data represents kept or walk-in appointments, sorted according to appointment types (see Table 4).

Table 4

Number of Orthopedic Clinic visits by patient appointment type

Patient Appointment Typé	Orthopedic Clinic Visits	
	Monthy	Daily Average
CON	229	10.4
FOL	652	29.6
INP	55	2.5
MEB	30	1.3
NEW	174	7.9
PHY	4	0.2
POP	91	4.2
SPC	55	2.5

Note. The CHCS patient types changed on 1 October 1997. NEW patients were seen by Orthopedic Surgeons only. There are 22 working days in an average month.

Patient arrival pattern.

Figure 8 depicts the overall patient arrival patterns in the Orthopedic Clinic during 1 Oct 97-31 Dec 97. Figure 9 illustrates the patient arrival patterns by CHCS appointment type for the same time period.

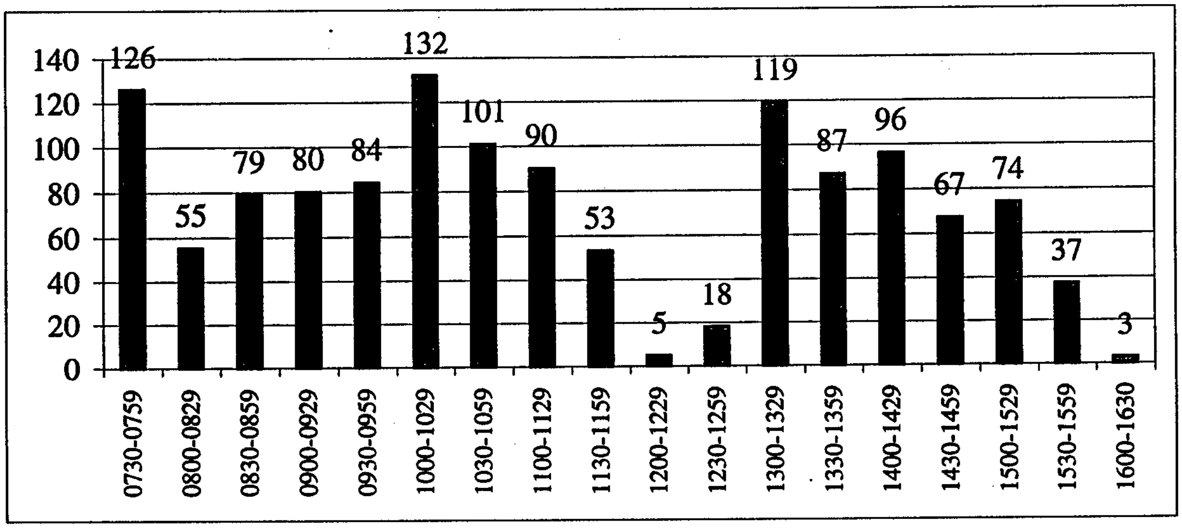

Figure 8. Total patient appointment type arrival patterns.

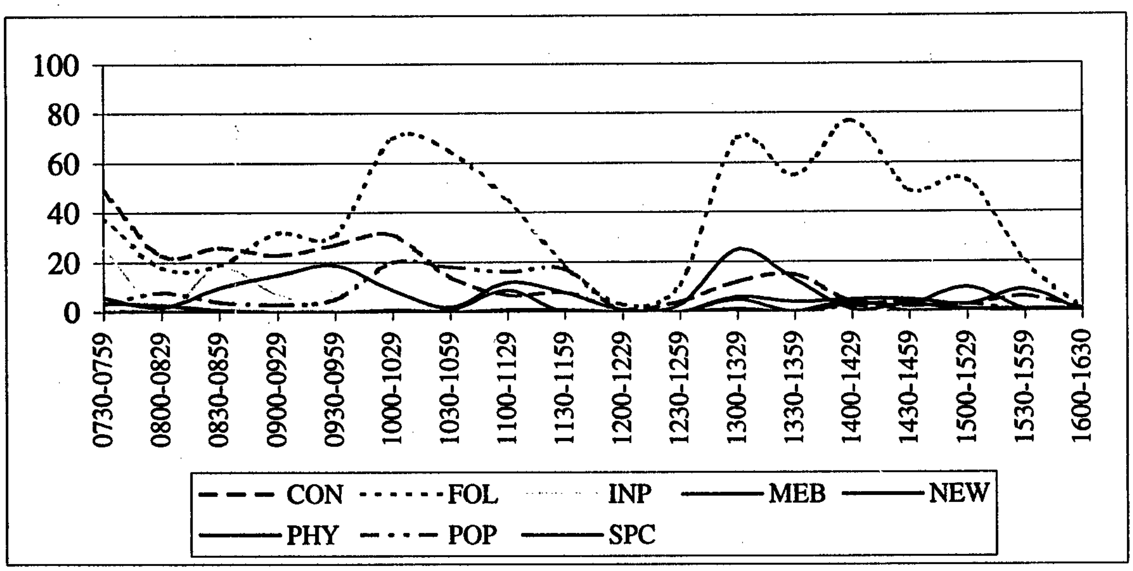

Figure 9. Patient arrival patterns by CHCS appointment type.

Appointment templates.

Both orthopedic surgeons and physician assistants use appointment templates to schedule patients (see Appendices G, H). The appointment templates provide a framework to establish how many of each type of patient should be seen in a clinic day and approximately how long the appointment should last. The orthopedic surgeons have five different templates depending on their schedule and the orthopedic physician assistants have two.

Provider workload.

The majority of an orthopedic surgeon's workload consists of performing surgery, treating patients in the clinic, and various administrative functions. Often, surgeons are scheduled to see patients in the clinic in the morning and then scheduled to perform surgery in the afternoon. Currently, when an orthopedic surgeon is scheduled for a full day of seeing patients in the clinic, he/she is scheduled to see 17 patients of various appointment types according to the provider template. Historical workload over a one year period (Jan 97-Dec 97) indicates that the average number of patients seen by the orthopedic surgeons per month is 92 (see Table 5). It is interesting to note that the median number of ambulatory patient encounters per month is 262 ("1997 Cost Survey Report," 1997). In the simulation model of the clinic, all workload data was obtained from clinic schedules.

Table 5

Orthopedic Clinic provider workload

Provider	Average Patients Seen	Average In Clinic Hours	Pts/Hour	AHA Standard Patients/Hour
Orthopedic Surgeon 1	85	62	1.37	3.44
Orthopedic Surgeon 2	174	97	1.79	3.44
Orthopedic Surgeon 3	119	119	1.09	3.44
Orthopedic Surgeon 4	128	128	1.26	3.44
Orthopedic Surgeon 5	113	113	1.18	3.44
Orthopedic Surgeon 6	117	117	1.41	3.44

Note. The source for the data was MEPRS and CHCS. The average patients seen (column two) was based on a surgeon schedule templated for only 17 patients a day. The patients/hour (column four) ratio is directly effected by factors such as patient no-shows and the clinic's support staff to surgeon ratio. According to American Medical Association data, the expected ambulatory encounter/per clinic hour ratio is 3.44.

Model building and analysis

Using a methodology similar to one developed by McGuire (1997), the model was developed in phases. In the first phase the floor plan for the model was built by first photocopying and then scanning the architectural blueprints of the Orthopedic Clinic. In the second phase, pathway networks were constructed depicting all possible avenues of patient movement through the clinic. Resources (orthopedic surgeons, orthopedic physician assistants, orthopedic technicians, x-ray technician, receptionists, and appointment clerks), entities (patients segregated into CHCS appointment types), shifts (working schedules for the resources), and distribution tables and patient arrival cycle patterns (distributions used in the model to determine when each type of patient arrived to the clinic were constructed). In phase three, the model was verified and validated.

After developing a base model (status quo), experiments were conducted using scenarios discussed below and the resulting changes in efficiencies were compared to the base model. The scenarios were developed by the researcher and a team of individuals consisting of orthopedic surgeons, the podiatrists, the clinic administrative officer, clinic non-commissioned officers, and orthopedic clerks and technicians. The scenarios include changes to the staffing level, patient flow, and other aspects of the base model. Comparing the resulting changes to the base model allows the researcher to identify the value of each scenario.

Each scenario included changes to: (a) staffing (the number and use of orthopedic surgeons, physician assistants, technicians and support personnel), (b) patient arrival patterns (how and when patients present to the clinic), (c) patient care areas (treatment rooms, x-ray rooms, reception desks, etc.), and (d) clinic architecture which determines patient flow through the clinic. Detailed listings of each simulation scenario can be found at appendix N.

Data collection

Patient flow and time tracking

The data determining patient waiting times and movement through the Orthopedic Clinic were collected by the researcher from a sample of patients (n=234) during a seven week period (15 Sep 97-31 Oct 97 and 5-9 Jan 98). Total patient time in the clinic, patient times at each various locations in the clinic, and information on how each patient moved through the clinic was collected using a data collection instrument filled out by the subject (patient) (see Appendix I). Several iterations of the instrument were evaluated until a final instrument design was determined. The sample data collection process was as follows: (a) the researcher was present in the clinic according to the random data collection periods discussed below; (b) subjects were meet at the door by the investigator and asked if they wanted to participate in an efficiency study; and (c) upon consent, subjects were given identification badges and data collection instruments and then self-recorded their arrival, treatment, and departure times at each location in the clinic. The researcher remained in the clinic to observe and answer subjects' questions about the instrument. Upon exiting the clinic, subjects returned the completed instruments to the receptionist who annotated the CHCS appointment type. The completed instruments were separated by CHCS appointment types and the data entered into MedModel's Stat::Fit application which determined the most appropriate distributions to use in the simulation model.

Sample Size

Table 6 represents the total number of the sample (n=234) used to determine patient flow and wait times at various locations in the Orthopedic Clinic. Although the sample size for certain appointment type is limited, an acceptable alternative is to use information provided by a subject matter expert (S. Denney, personal conversation, 27 October 1997).

Table 6

Sample sizes

CON	FOL	NEW	INP	MEB	POP	SPC	PHY
41	70	41	28	11	32	11	0

Note. Data collection periods were 15 Sep 97–31 Oct 97 and 5–9 Jan 98.

Randomness

Randomness of the sample was ensured by randomly selecting times during the data collection period to collect patient data in the Orthopedic Clinic. Data collection times were determined by first associating the clinic's operating hours with shift numbers (see Table 7) and then selecting two shift numbers per day using a random number generator table. For example, if shift numbers two and eight were selected for the 17th of October, patient data would be collected during 0830-0929 and then again 1430-1529 on the 17th of October.

Table 7

Clinic operating hours and assigned shift number

Operating Hours	Assigned Shift Number
0730-0829	1
0830-0929	2
0930-1029	3
1030-1129	4
1130-1229	5
1230-1329	6
1330-1429	7
1430-1529	8
1530-1630	9

Note. Although shift nine terminates at 1630, patients remaining in the Orthopedic Clinic after 1630 continued to be observed.

Validation of the Model

Validation of a simulation model is a process of comparing actual patient flow with the simulation model results (McGuire, 1997). Lowery and Martin (1992) categorized the process of model validation as being either subjective or objective. Subjective methods involve the assessment of face validity given by subject matter experts observing the model and agreeing with its accuracy. Objective methods are more rigorous and involve the statistical comparison between the means of observed and simulated data. Although objective methods of validation are preferred, there are required elements that must be present before these methods can be attempted. These requirements include: (a) determining the importance of the variable; (b) available, accurate observed data; and (c) determining how sensitive the outputs are to deviations from the model's assumptions (Lowery and Martin, 1992).

Although the importance of the each variable and the model's sensitivity could be determined, the observed data was limited its accuracy due to small sample size. Because of this, this study did not meet all requirements for using an objective method, and a subjective validation method recommended by Law and Kelton (1991) was used. The Law and Kelton (1991) method involves presenting separate unlabeled graphs depicting observed and simulation data for each of the variables to the subject matter experts. The inability to distinguish between the simulated and actual data validates the model (Law and Kelton, 1991).

Using this method, the Orthopedic Clinic's leadership and subject matter experts were presented graphs depicting simulated and actual data arrayed together (see Appendix O). The base model was validated when the clinic experts were unable to identify which data set on the graph was observed or simulated data. Additionally, face validity was obtained when the Orthopedic Clinic's staff observed the base simulation model and agreed with its accuracy.

Simulation repetitions

After validating the model, it was necessary to determine how many replications of each scenario are required to produce statistically significant results. Using the below equation taken from the MedModel Training Manual

(1993), it was determined that each simulation scenario should be replicated at least 117 times. In this study, each scenario will be replication 250 times, simulating one year's worth of clinic workload.

$$n = \left(\frac{Z * \hat{s}}{3} \right)^2$$

Note. n= number of simulation replications required for significance, Z= the precision level (i.e. for 95% confidence interval, Z=1.96), s= the estimated standard deviation, and 3= nearness to the decision variable (i.e. within 3 minutes).

Assumptions

The following assumptions are made: (a) all providers work at a similar rate; (b) the Orthopedic Clinic staff continues to work until all patients have exited the clinic; and (c) 250 simulation replications equals one year of clinic workload.

Limitations

The study contains the following limitations: (a) using identification badges to collect data potentially created a "Hawthorne effect"; (b) accuracy of the CHCS, ADS, and MEPRS data; (c) minor changes were made in clinic procedures during the data collection period; (d) second hand data; (e) limited period of historical data (15 Oct 97-15 Nov 97); (f) patients recorded their own times; (g) workload data does not capture provider interruptions (e.g. phone calls and unexpected interruptions); and (h) small sample sizes.

Ethical Considerations

There was no record of any names of individuals involved in the study. There was no effort to identify or compare provider performance data by name.

CHAPTER 3

Results

The optimal operational concept was defined as the simulation scenario that produced the greatest number of patients seen in the clinic while minimizing the amount of time in the clinic for the patient. Additionally, the optimal scenario must meet the TRICARE in clinic wait time standard of 30 minutes. Interpretation of the simulation data indicated that scenario ten provided the optimal operational concept in the Orthopedic Clinic.

Scenario ten consisted of the following changes to current clinic operations: (a) adding an additional x-ray technician; (b) clinic redesign to include consolidation of the reception, appointment, and screening areas; (c) changing the patient arrival patterns to a modified wave concept; (d) increasing the amount of patients seen by each orthopedic surgeon from 17 to 25; (e) assigning a specific orthopedic technician to work with a specific orthopedic surgeon; and (f) having the receptionists conduct the patient screening. Scenario ten increased the total number of patients seen in a week from the 429 patients to 575 patients while decreasing both the total time in clinic and waiting times for the patient. Although scenario ten did increase the clinic's staff utilization percentages, they are still believed to be within an acceptable estimate (see Tables 8 and 9).

To determine if the results were not a result of random variance, an analysis of variance (ANOVA), using a level of significance of α=.05, was conducted (see Appendix O). An ANOVA is a parametric statistical analysis which allows us to use sample data to see if the values of two or more unknown population means are likely to be equal. Parametric statistical analysis is preferable to nonparametric analysis because it is more powerful and more sensitive (Sanders, 1995).

Table 8

Descriptive Data (means) for Variables 1-5

	Variables (1-5)				
Scenarios	In System (Minutes)	Waiting (Minutes)	In Operation (Minutes)	Run Time (Hours)	Patients
Base Scenario	**74.54**	**39.26**	**35.25**	**104.78**	**429**
1. Scenario one	68.52	33.42	35.22	104.83	429
2. Scenario two	76.92	41.75	35.14	104.78	461
3. Scenario three	72.73	37.42	35.27	104.84	461
4. Scenario four	92.30	58.02	34.21	106.84	429
5. Scenario five	92.37	56.76	34.16	105.64	552
6. Scenario six	119.78	85.92	33.85	105.64	607
7. Scenario seven	91.2	62.99	31.16	105.14	583
8. Scenario eight	62.34	31.2	31.85	104.89	429
9. Scenario nine	64.38	33.91	31.14	105.12	461
10. Scenario ten	**51.42**	**25.27**	**27.34**	**105.14**	**575**

Note. Detailed descriptions of the scenarios can be found in Appendix N. Scenarios eight, nine, and ten all involve clinic redesign.

Table 9

Descriptive Data (means) for Variables 6-10

	Variables (6-10) Staff Utilization Percentages				
Scenarios	Surgeons	Physician Assts	x-ray tech(s)	Ortho techs	Ortho clerks
Base	**61.59%**	**51.82%**	**40.76%**	**26.14%**	**13.2%**
Scenario one	59.72%	49.21%	42.66%	29.38%	13.52%
Scenario two	61.70%	49.02%	42.66%	26.12%	13.52%
Scenario three	59.72%	49.02%	42.66%	29.38%	13.52%
Scenario four	65.46%	53.45%	44.66%	34.25%	15.32%
Scenario five	67.46%	53.45%	48.52%	34.32%	15.32%
Scenario six	67.46%	53.45%	48.52%	34.32%	15.32%
Scenario seven	78.09%	41.63%	65.52%	41.72%	17.89%
Scenario eight	59.12%	48.8%	36.55%	36.55%	19.98%
Scenario nine	66.13%	53.47%	36.55%	42.37%	20.18%
Scenario ten	**66.45%**	**56.73%**	**47.32%**	**48.58%**	**22.34%**

Note. The staff's utilization percentages were based on direct patient contact time in the simulation model. These percentages do not take into consideration time spent answering the phone or other activities.

CHAPTER 4

Discussion

The purpose of the study was to determine the optimal operational concept for the Orthopedic Clinic using simulation. Each simulation scenario provided insight to the effects of alternating major components (staff, patient arrival patterns, and clinic architecture) of clinic operation. Initially, the simulation scenarios involved changing only one aspect of a major component and then progressed to scenarios that incorporated multiple changes to several components.

Staff

The first four scenarios involved manipulating the number, responsibilities, and type of staff assigned to the Orthopedic Clinic. These scenarios involved: (a) increasing the number x-ray technicians; (b) increasing and decreasing the number of orthopedic surgeons; (c) increasing the number of available orthopedic technicians; and (d) changing the duty responsibilities of the orthopedic clerks.

X-ray technicians.

The Orthopedic Clinic's leadership believed that only having one x-ray technician working full time in the Orthopedic Clinic limited timely access to x-ray and contributed to extended patient waiting time. The problem with timely access to x-ray seemed to be aggravated when more than three of the surgeons were scheduled to see patients in the clinic at the same time. In an attempt to confirm these beliefs, a scenario was created which added an additional x-ray technician while every thing else remained constant. The results of the simulation indicated a decrease in the average total time in clinic for the patients by 6.31 minutes which demonstrates that an additional x-ray technician was an effective change. Additionally, the results from other scenarios indicated that having an additional full time x-ray technician was vital to support an increase in the number of patients seen.

Orthopedic surgeons.

A simulation scenario tested the effect of increasing the orthopedic surgeons' workload while other aspects of the clinic remained constant. This scenario was based on the clinic leadership's belief that the surgeons' schedules were inefficient which resulted in excessive idle time. Although this scenario did increase the total number of patients seen in the clinic by 32 patients a week, it also increased the total time in the clinic for the patients by an average of three minutes. Additionally, this scenario did not meet the TRICARE in clinic wait time standard of 30 minutes.

Primarily because one of the orthopedic surgeons was scheduled to leave in June 1998 without a replacement, the clinic's leadership requested a simulation scenario that decreased the number of orthopedic surgeons by one with no reduction in the current patient workload. Although this scenario only increased the surgeon utilization percentages by 4%, the total time in the clinic for the patients increased by 18 minutes and did not meet TRICARE standards. The results of these scenarios indicated that the surgeons' workload should not be increased without changing other aspects of current clinic operations.

Orthopedic technicians and clerks.

The results of several simulation scenarios indicated that increasing the number of available technicians was a significant factor in improving clinic efficiency and reducing the total time in clinic for the patients. Having technicians available to escort patients into treatment rooms and prepare them for their procedures increased surgeon efficiency allowing for more patients to be seen in less time. In order to increase the number of available technicians, the orthopedic clerks should be consolidated in one location and cross-trained to perform the screening functions currently done by the technicians. Consolidation of the orthopedic clerks can be accomplished through clinic redesign, which is discussed later.

Patient arrival patterns

Several scenarios tested the effects of altering patient arrival patterns. These scenarios included eliminating the patient no-show rates, and changing the patient appointment system to a modified wave concept which was discussed in the literature review. The results of these simulations indicated that patient arrival patterns had a pronounced effect on the clinic. Although each of these scenarios increased the number of patients seen, they also increased the total time in the clinic for the patients unless they were combined with other clinic modifications (e.g. clinic redesign). These results indicate that just increasing the number of patients seen in the clinic is not the answer to improving efficiency because the increased workload overwhelms the support staff.

Clinic architecture

The clinic's current architectural design locates the main reception desk close to the entrance of the clinic. While this design facilitates the monitoring of the entrance, patients waiting to check in with the receptionist often form a queue and partially block the entrance to the clinic. The researcher observed this problem on several occasions and in all of the simulation scenarios not involving the clinic's redesign. In addition to the problem at the entrance, other design problems in the clinic included separate main reception, patient screening, appointment, and podiatry reception locations. Patients moving through the clinic can potentially stop at six different locations before completing their episode of care.

Because of these issues, the clinic's leadership requested a simulation scenario that relocated the main reception areas and consolidat~~ing~~ed all the patient administration areas (reception, screening, appointments, etc). Combinations of the clinic redesign were tested with the current arrival patterns, reduced no-show rates, and the modified wave concept of patient arrivals. The simulation results indicated that the clinic redesign decreased the total time in clinic for each scenario. Additionally, it was not until the clinic was redesigned in the model that the patients' clinic waiting time met the TRICARE standard.

Additional observations

While in the process of developing and comparing each simulation scenario certain areas were identified as being important to clinic operation and warrant further discussion. These areas focus on surgeon efficiency, support staff ratios, and patient no-show rates. Additionally, reasons defining why the clinic should become more efficient are discussed.

Surgeon efficiency.

The simulation analysis determined that a significant factor in clinic efficiency was surgeon efficiency. It was interesting to note the relationship between significant clinic events involving surgeons (e.g. orthopedic surgeon deployments and availability, appointment template changes, etc.) and their impact on surgeon efficiency. For example, in April 1997 the orthopedic surgeons were mandated to increase the number of Medical Evaluation Board (MEBs) conducted daily from one to two in an attempt to improve MEB processing times (personal conservation, S. Larson, 15 January 1998). Although this may seem like an insignificant change, it actually had a pronounced effect on clinic efficiency. Because each MEB is templated for one hour of a surgeon's time, increasing the number of MEBs greatly reduced the number of other appointment types the surgeons could have completed. For example, in that same hour, six post operative visits or three follow-up visits could have been conducted. The effect of the MEB policy change manifested in early July and was a contributing factor in the decreased number of patients seen during July, August, and September. It is only when an additional surgeon arrived in late September that the number of patients seen in the clinic increased (see Figure 10).

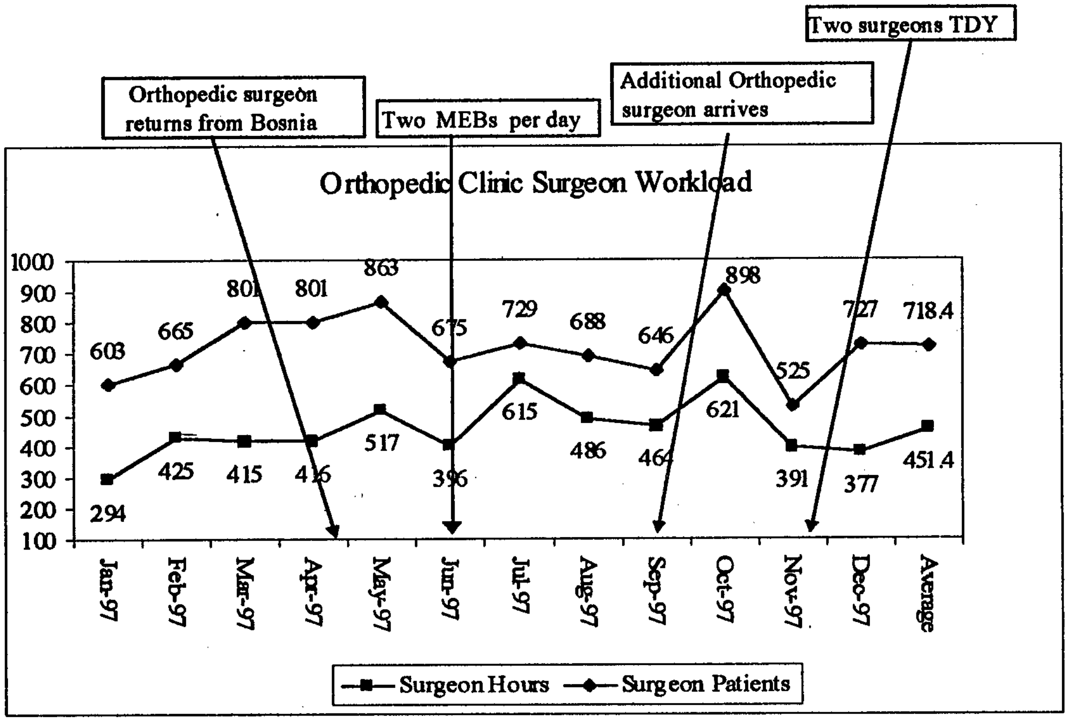

Figure 10. Orthopedic Clinic workload and significant events.

Table 10 depicts the average orthopedic surgeon efficiency for each month in calendar year 1997. Using an efficiency measuring technique developed by Holmes (1993) an efficiency ratio for the orthopedic surgeons was obtained by dividing the total number of patients seen by the surgeons' reported MEPRS in-clinic hours. This data identified performance comparisons that can be used as a management tool to improve clinic operations.

Table 10

Orthopedic surgeon efficiency

Surgeon	Average In Clinic Hours	Average Patients Seen	Pts/Hour	AHA Standard Pts/Hour
Surgeon 1	62	85	1.37	3.44
Surgeon 2	97	174	1.79	3.44
Surgeon 3	110	118	1.07	3.44
Surgeon 4	101	128	1.26	3.44
Surgeon 5	95	113	1.18	3.44
Surgeon 6	82	117	1.41	3.44

Note. Data Sources: MEPRS, CHCS reports calendar year 1997. The average patients seen (column two) was based on a surgeon's schedule templated to see 17 patients a day. The patients/hour (column four) ratio is directly effected by factors such as the clinic's support staff to surgeon ratio and patient no-shows. According to American Hospital Association (AHA) data, the expected ambulatory encounter/per clinic hour ratio is 3.44.

Staffing ratios.

Several simulation scenarios and the orthopedic surgeon efficiency analysis confirmed the importance of adequate staffing ratios. Although the current authorized staffing level in the Orthopedic Clinic yields a 1:1 orthopedic surgeon to orthopedic technician ratio, the actual in clinic ratio is frequently less than 1:1 (S. Larson, personal conversation, 21 February 1998). According to the 1997 Cost Survey Report produced by the Medical Group Management Association (MGMA), the median ratio of orthopedic surgeon to medical (non-administrative) support staff (Registered Nurses, Licensed Practical Nurses, and orthopedic technicians) was 1:1.46. While these staffing ratios do not appear to be significantly different, the MGMA ratio includes Registered Nurses and Licensed Practical Nurses who are qualified to perform a broader range of technical tasks than an orthopedic technician. When the clinic's staffing ratio was compared to a civilian orthopedic clinic in the local area, a dramatic difference in the staff ratio was noticed. Premier Orthopedic Clinic is a four surgeon practice is located in Clarksville, Tennessee. Premier's orthopedic surgeons are able to see approximately sixty patients in a four to five hour period. Premier's lead surgeon believes that they can see a comparatively high volume of patients because the staffing ratio is four support staff (two are registered nurses) to every surgeon. Because of this ratio, each surgeon is allowed to concentrate on aspects of patient care that only a surgeon can provide while the support staff completes almost everything else (e.g. required paperwork, prescriptions, instructions, etc.) (S. Beasley, personal conversation, 17 February 1998).

<u>Orthopedic Clinic no-show rates.</u>

A no-show occurs when a scheduled patient does not present for his/her appointment and does not notify the clinic's staff. No-shows have an extremely detrimental effect on the efficiency of an orthopedic surgeon and the clinic in general because the majority of times the no-show appointment slot cannot be re-booked and the providers' time goes idle. Several literature sources [Larose (1996), Matthies (1995)] note that in a busy clinic with tightly packed schedules missed appointments can have a negative impact on efficiency, and chronic no-shows are an obstacle to efficient use of the staff, professional time and clinic facilities. Currently, the Orthopedic Clinic maintains a monthly average of 7.27% no-shows which is greater than hospital's average of 5.23% (see Figure 11).

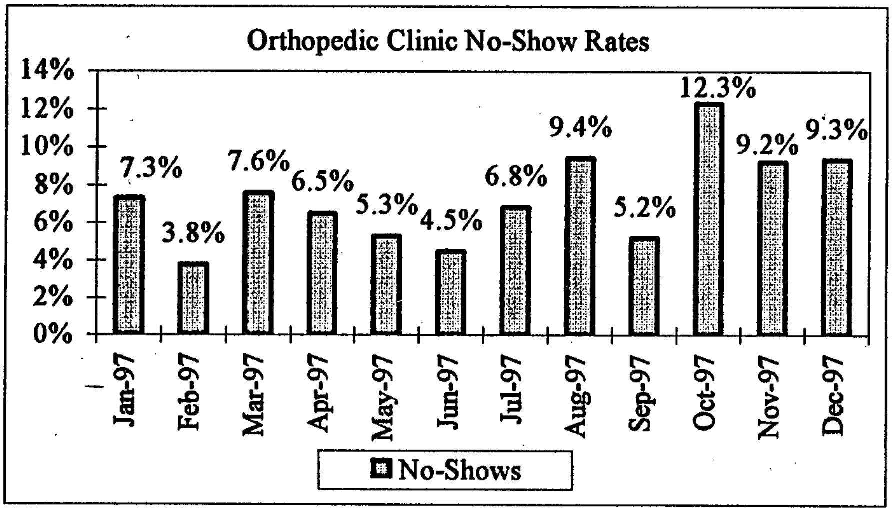

Figure 11. Calendar year 1997 no-show rates for the Orthopedic Clinic.

A potential contributing factor to increased patient no-shows rates during certain months may be deployments conducted by units assigned to the 101st Airborne Division (Air Assault). For example, the no-show rates in the Orthopedic Clinic were high during the months of March, October, November, and December 1997. These same months parallel major training deployments of at least one brigade size element of soldiers assigned to 101st Airborne Division (Air Assault) to either the Joint Readiness Training Center (JRTC) or the National Training Center (NTC) (see Table 11).

Table 11

Related major unit training excerices

Major Training Deployments	Dates	Size
JRTC 97-03	Jan 97	1 Brigade (2,000 Soldiers)
JRTC 97-05	Mar 97	1 Brigade (2,000 Soldiers)
JRTC 97-06	Apr 97	1 Brigade (2,000 Soldiers)
NTC 98-02	Oct/Nov 97	2 Brigades (4,000 Soldiers)

Note. The data source was the 101st Airborne Division's training calendar. One Brigade size element is roughly equivalent to 2,000 soldiers.

The suspected link between military specific training events and the no-show rate is supported by Larose (1996). Larose (1996) stated that no-show rates tend to vary widely depending on the setting and the individualities of the patient population (Larose, 1996). A study conducted at RAND found that some of the "individualities" of active duty military healthcare beneficiaries included being susceptible to deployments and the removal of personal financial responsibility for healthcare services (Hosek, et al. 1995).

Figure 12 depicts the number of no-shows added to the number of patients actually seen in the Orthopedic Clinic. These figures potentially represent the total number of patients who could have been seen in the clinic had the no-shows been eliminated.

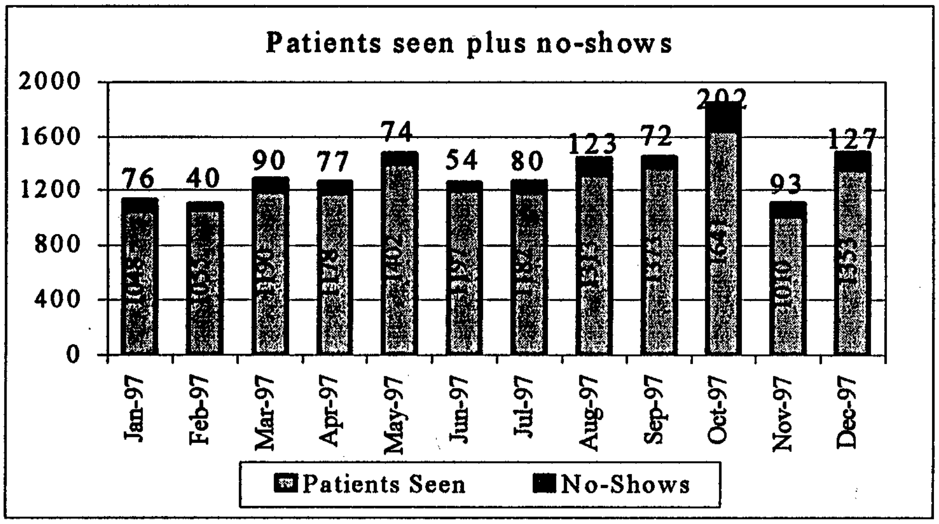

Figure 12. The number of patients the Orthopedic Clinic was scheduled to see.

Reasons to improve efficiency

It is imperative to improve the Orthopedic Clinic's efficiency in order to reduce the extensive patient backlog, meet TRICARE access and in-clinic wait time standards, and improve both staff and customer satisfaction. Actual clinic observation has supported the initial perceptions that the clinic was not meeting TRICARE access and in-clinic waiting time standards. Under TRICARE, failure to meet these standards will result in monetary losses to the hospital.

Predicting Orthopedic Clinic utilization.

When TRICARE begins, the active duty population is predicted to remain constant (around 23,460 generating 10,888 Orthopedic Clinic visits a year), so the greatest potential change in utilization will be created by the other than active duty (ADD, NADD) populations enrolled in TRICARE Prime with guaranteed access standards. Determining if the expected utilization rate generated among the ADD/NADD TRICARE Prime enrollees is greater than the current annual requirement of 3,831 visits is vital to resource protection.

An estimated Orthopedic Clinic utilization for other than active duty populations enrolled in TRICARE Primes at BACH can be obtained by comparing Orthopedic Clinic utilization rates generated by the same populations enrolled in TRICARE Prime at similar military treatment facilities already under TRICARE. Two military treatment facilities (Evans and Winn Army Community Hospitals) were selected based on similarity of facility size, staffing, beneficiary population with BACH (see Table 12).

Table 12

ADD/NADD TRICARE Prime Orthopedic Clinic utilization rates among like-sized facilities

Medical Activity	TRICARE Prime (ADD)	TRICARE Prime (NADD)	Annual Orthopedic Utilization among ADD/NADD	Standardized Annual Utilization Rate
Evans ACH	18,934	6,088	3,645	153/1000
Winn ACH	19,955	4,912	3,514	141/1000

Note. Data sources were Patient Administration Systems and Biostatistics Activities (PASBA), World Wide Workload (WWW) report dated 5 February 1998, and personal conversation with each medical activity. Column four (Annual Orthopedic Utilization among ADD/NADD) is the annual Orthopedic Clinic utilization figures generated by the ADD/NADD beneficiaries enrolled in TRICARE Prime at the respective Army Community Hospital (ACH). Column five (Standardized Annual Utilization Rate) is derived by dividing column four (Utilization among ADD/NADD) by the combination of columns two [TRICARE Prime (ADD)] and three [TRICARE Prime (NADD)].

Taking an average of the standardized utilization annual rates from table 12 and applying it to BACH's predicted ADD, NADD TRICARE Prime beneficiary population (columns two and three in Table 13) provides an estimate of the annual Orthopedic Clinic utilization required by this population (see Table 13).

Table 13

Predicted ADD/NADD TRICARE Prime Orthopedic Clinic utilization rates

Medical Activity	TRICARE Prime (ADD)	TRICARE Prime (NADD)	Standardized Annual Utilization Rate	Predicted Annual Utilization (ADD/NADD)
Blanchfield ACH	21,351	10,462	147/1000	4,676

Note. The figure in column five [Predicted Annual Utilization (ADD/NADD)] was obtained by multiplying column four (Utilization Rate) with the summation of columns two [TRICARE Prime (ADD)] and three [TRICARE Prime (NADD)].

Projected requirements compared to calendar year 97 data

The predicted annual utilization generated by the NADD, ADD TRICARE Prime at BACH beneficiary population is 4,676 visits. This predicted value (4,676) added to the 1997 active duty requirements (10,888) equals 15,564 which is 662 greater than the 1997 requirements. Assuming seasonal variability in utilization remains constant, this would result in an increase of 55 (662/12) patient visits per month (see Figure 13).

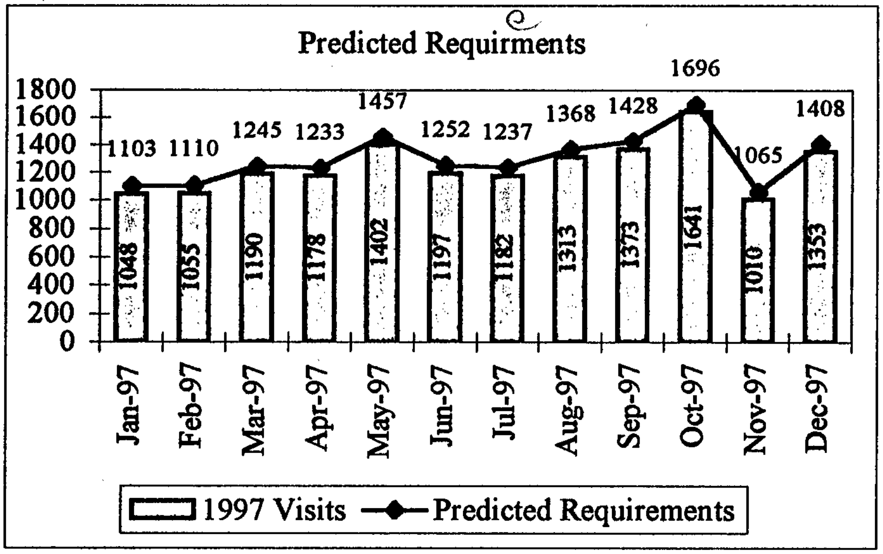

Figure 13. 1997 Orthopedic Clinic visits compared to predicted requirements.

CHAPTER 5

Conclusion and Recommendations

Determining the optimal operational concept in the Orthopedic Clinic involves implementing recommendations that are a combination of those validated through computer simulation and those resulting from personal observation supported by literature review. Implementing the recommendations should produce a dramatic improvement in the efficiency of the clinic allowing it to meet TRICARE standards while improving both patient and provider satisfaction.

Clinic architecture

The clinic should consolidate the main reception desk, podiatry reception desk, appointment desk, and screening desk in a newly constructed centralized reception area located in the patient waiting room (see Annex M). This change will eliminate the bottleneck created at the entrance to the clinic and facilitate patient flow. The central reception will also serve as a centralized business office (see Annex R).

Support staff to surgeon ratio

With the creation of the centralized reception area all the orthopedic clerks will be located in the same area. The consolidation of the clerks should allow for an orthopedic technician to be freed from current duties as a receptionist. Additionally, orthopedic technicians should be freed from the duties of screening.

This will increase the orthopedic technician to orthopedic surgeon ratio and allow for specific orthopedic technicians to be assigned to specific surgeons.

Patient appointment system

The current patient appointment system uses identical appointment templates for all six orthopedic surgeons. This causes the same appointment types (e.g. FOL, NEW, POP, etc.) to arrive at the clinic at the same times (see Figures 8, 9). Usually, these appointment types have similar resources requirements (e.g. x-ray, cast removal, etc.), resulting in bottlenecks. To improve this situation, the surgeons' appointment templates should be reorganized to incorporate a "modified wave" scheduling technique. Using Schurart's (1994) concept of a modified wave, the patient appointments should be set up so several patients arrive at one time, then none scheduled and then additional patients instead of one patient every ten minutes (Schurart, 1994). Additionally, the clinic's leadership should investigate the practicality of the pre-registration of patients scheduled to return to the clinic and attempt to decrease the walk-in to appointment ratio by scheduling patients seen in the emergency room (see Appendix Q).

Reduction of no-shows

LaRose (1996) states that patients should be educated about keeping their appointments and provides the following recommendations to reduce no-show rates which can be applied in the Orthopedic Clinic: (a) identify which types of patients are not showing up and target that population; (b) do not punish no-show patients, just inform them of the importance and demonstrate concern for their health; (c) call the no-show and involve them in the process of rescheduling their appointment; and (d) set goals for reducing the no-show rate.

Several literature sources [Shenkel (1995), Karp, (1995) and Matthies (1995) state the value of a patient reminder system to reduce the no-show rates. Because personal telephone calls to remind patients of their appointments would be time consuming, an automated patient reminder system should be purchased. Additionally, prior to scheduling active duty patients for an appointment, the clerks should check the 101st Airborne Division (Air Assault) training calendar to see if the soldier's unit of assignment is scheduled for a major training exercise which conflicts with the appointment date.

Orthopedic Clinic's staff responsibilities

All of the orthopedic clerks should be cross-trained to perform each other's job. The responsibility to answer the phone should be removed from the orthopedic clerk working at the reception area to another staff member who is not performing direct patient care activities. Additionally, the surgeons should identify all non-essential surgeon activities and determine which other individuals can perform these functions. The surgeons must delegate every task short of compromising the quality of care.

Leadership

The non/commissioned officer in charge (NCOIC) and administrative officer of the perioperative services should spend a full week acting as the clinic managers in order to gain a better understanding of the clinic's functions and activities. In order to facilitate taking a more active role in clinic management, the Orthopedic Clinic's NCOIC office should be relocated adjacent to the reception area. Additionally, the clinic's NCOIC/OIC should be provided training on the principles of effective clinic management and continue to monitor the efficiency indicators identified in the study.

Further Study

A follow-up study re-measuring the same variables and efficiency indicators used in the study should be conducted after the recommended changes have been implemented. Additional study should be conducted exploring the role and use of the orthopedic technicians. Further study should explore the feasibility of: (a) orthopedic phone triage; (b) interactive preoperative orthopedic briefings conducted on the Internet; and (c) the development of clinical pathways for high volume conditions.

Conclusion

The simulation study proved to be an effective method of comparing alternative approaches to improve efficiency in the Orthopedic Clinic. Computer based simulation removes personal biases and its graphic interface allows individuals being studied to become motivated about the project. Because of this, several recommendations validated by the computer simulation have been implemented (see Afterword).

The recommendations made in this study are similar to recommendations made in August 1995 study. It is important to note that the 1995 study recommendations were only partially implemented and resulted in increased dissatisfaction among both the staff and patients. The dissatisfaction resulted from increasing the number of patient appointments without making any other process changes (S. Larson, personal conservation, 11 February 1998). The results of the simulation study clearly demonstrated the importance of an "all or none" approach to improving the Orthopedic Clinic with the primary element being the clinic renovation.

Afterword

As a result of the simulation study the following changes have been implemented in the Orthopedic Clinic: (a) new appointment templates have been implemented which increase the number of patients seen per day from 17 to 25 patients per surgeon (see Appendix S); (b) the templates have been individualized allowing for the surgeons to tailor their types of patient appointments to reduce their backlog; (c) the orthopedic technician working as a receptionist has been reassigned as a technician; (d) the architectural design for the consolidated reception area and business office has been completed (see Appendix R); (e) the hospital commander was briefed and approved the recommendations pending completion of business plan; (f) a method of scheduling patients seen in the emergency room has been established (see Appendix O); and (g) an automated patient reminder system for the hospital is under study.

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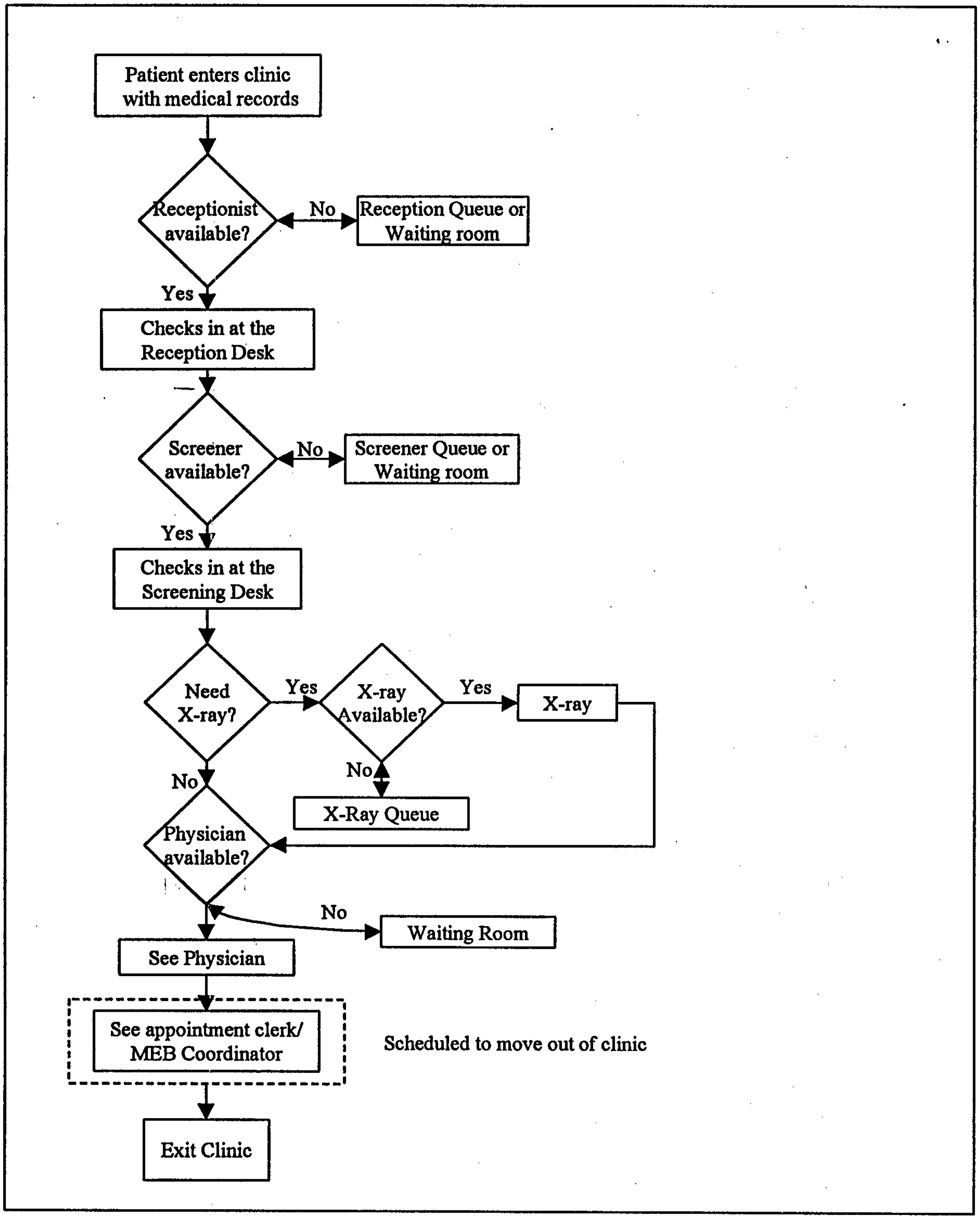
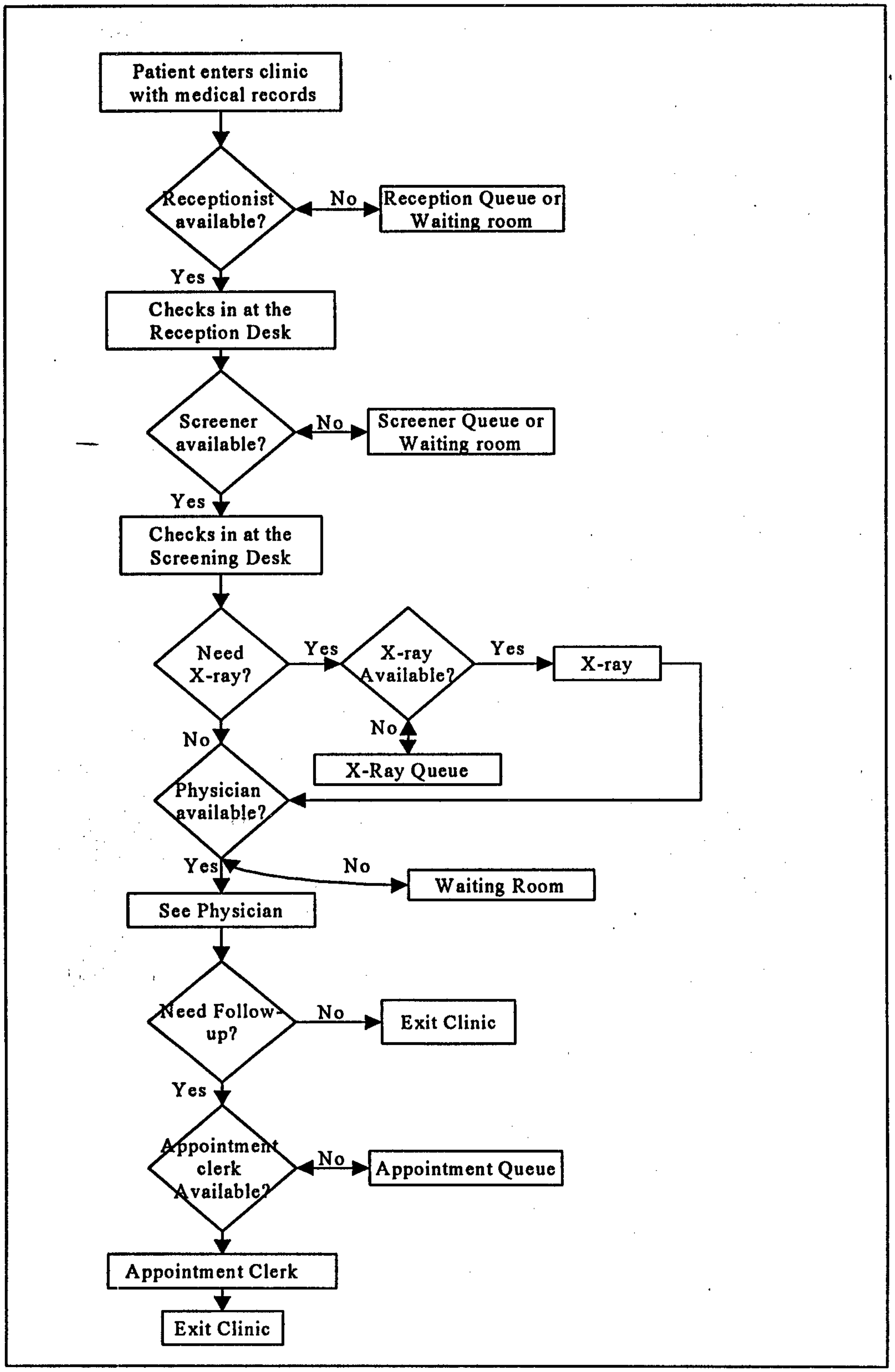
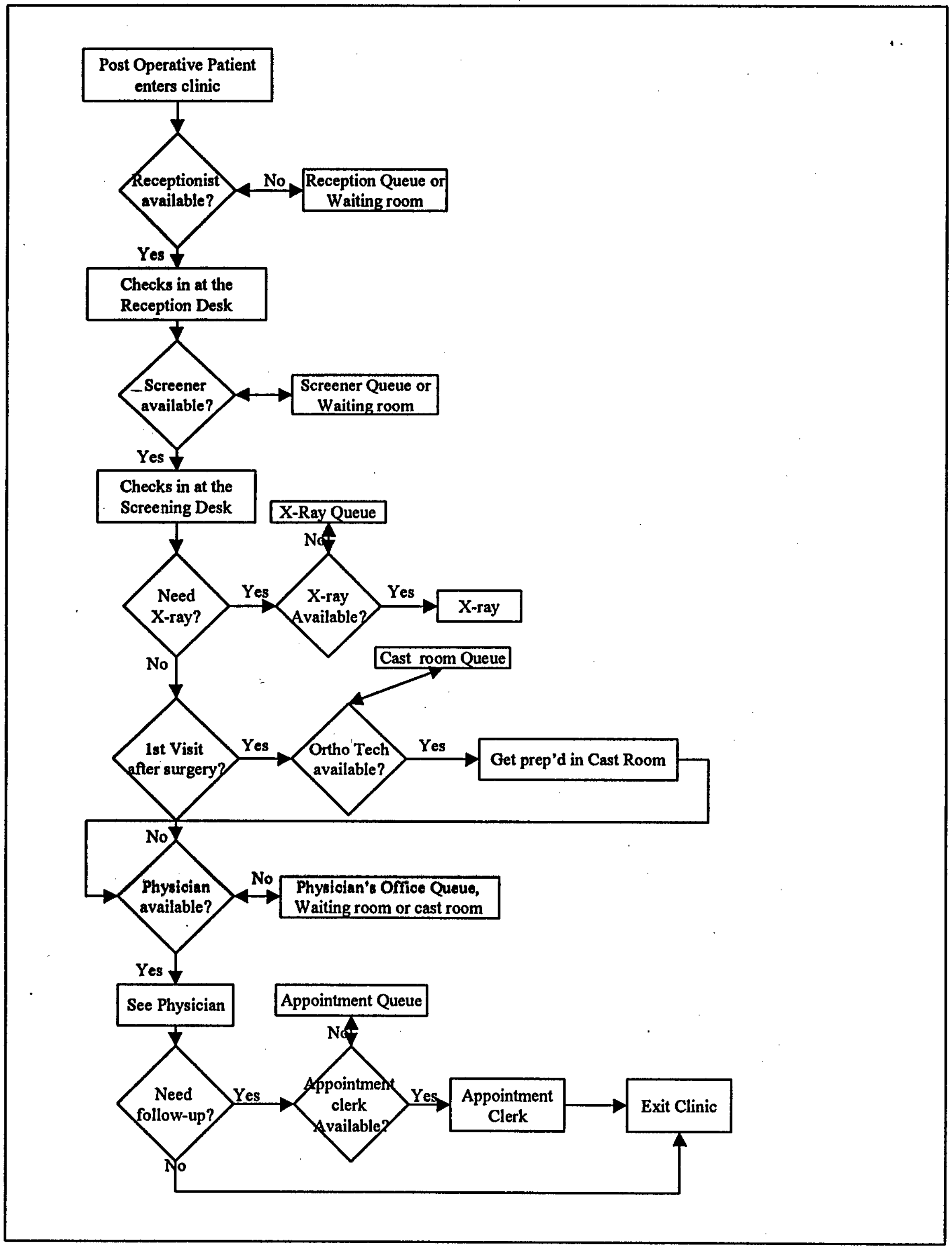
Appendix A (MEB) Flowchart



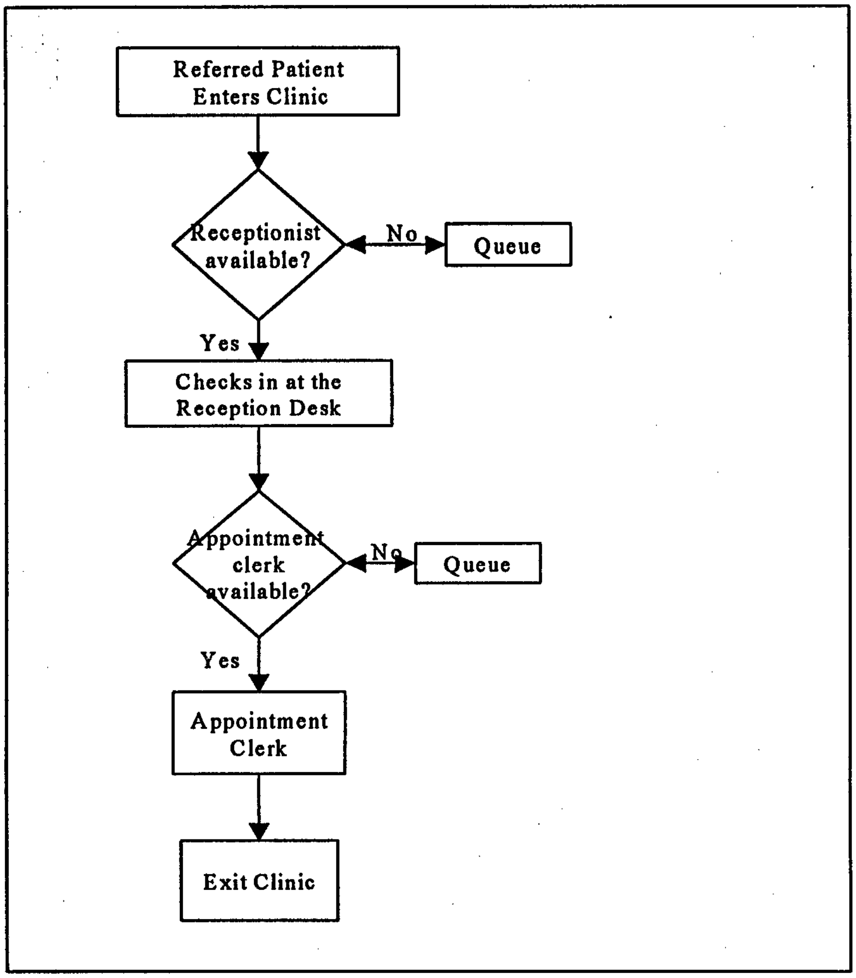
Appendix B (NEW) Flowchart



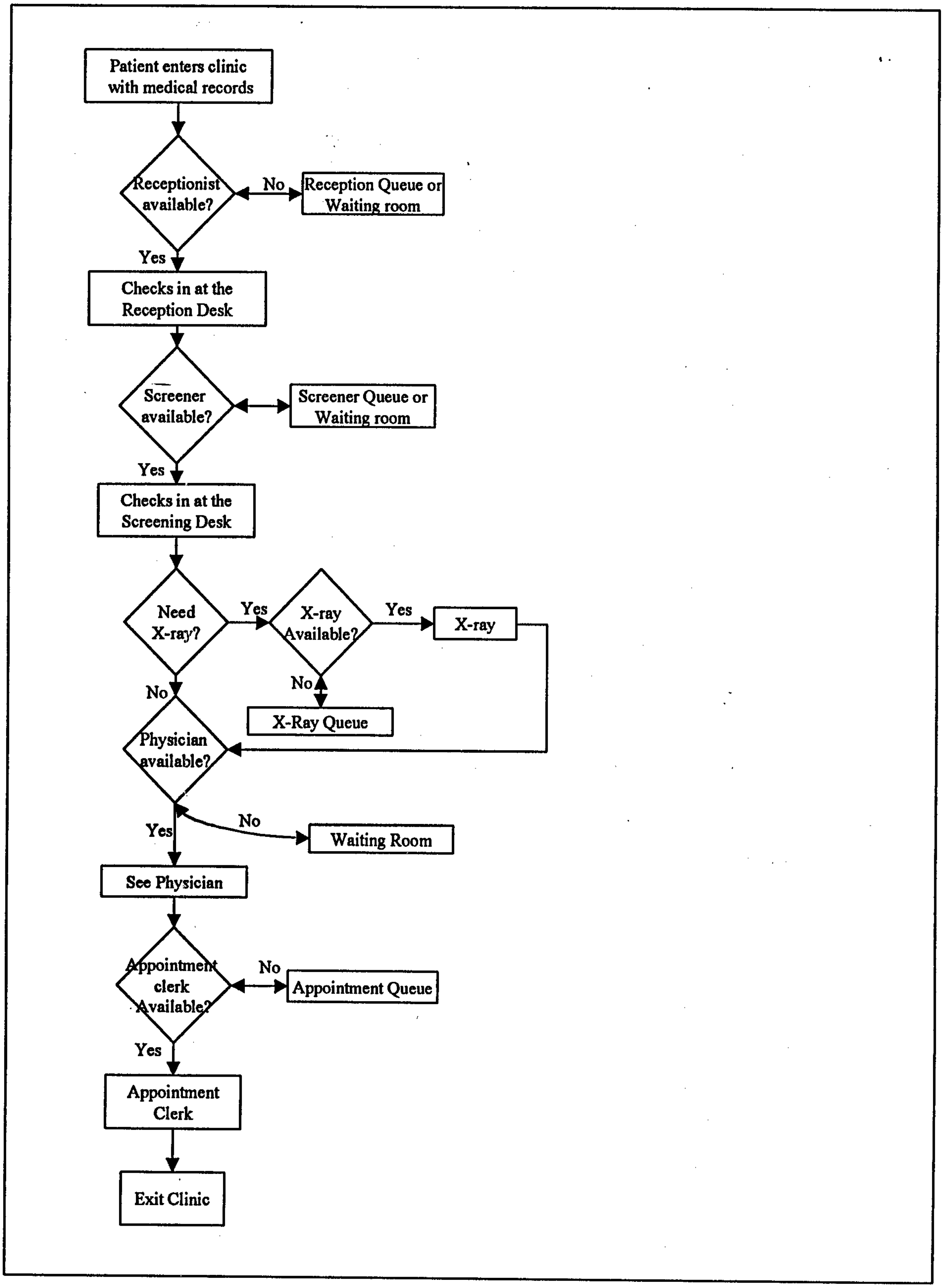
Appendix C (POP) Flowchart



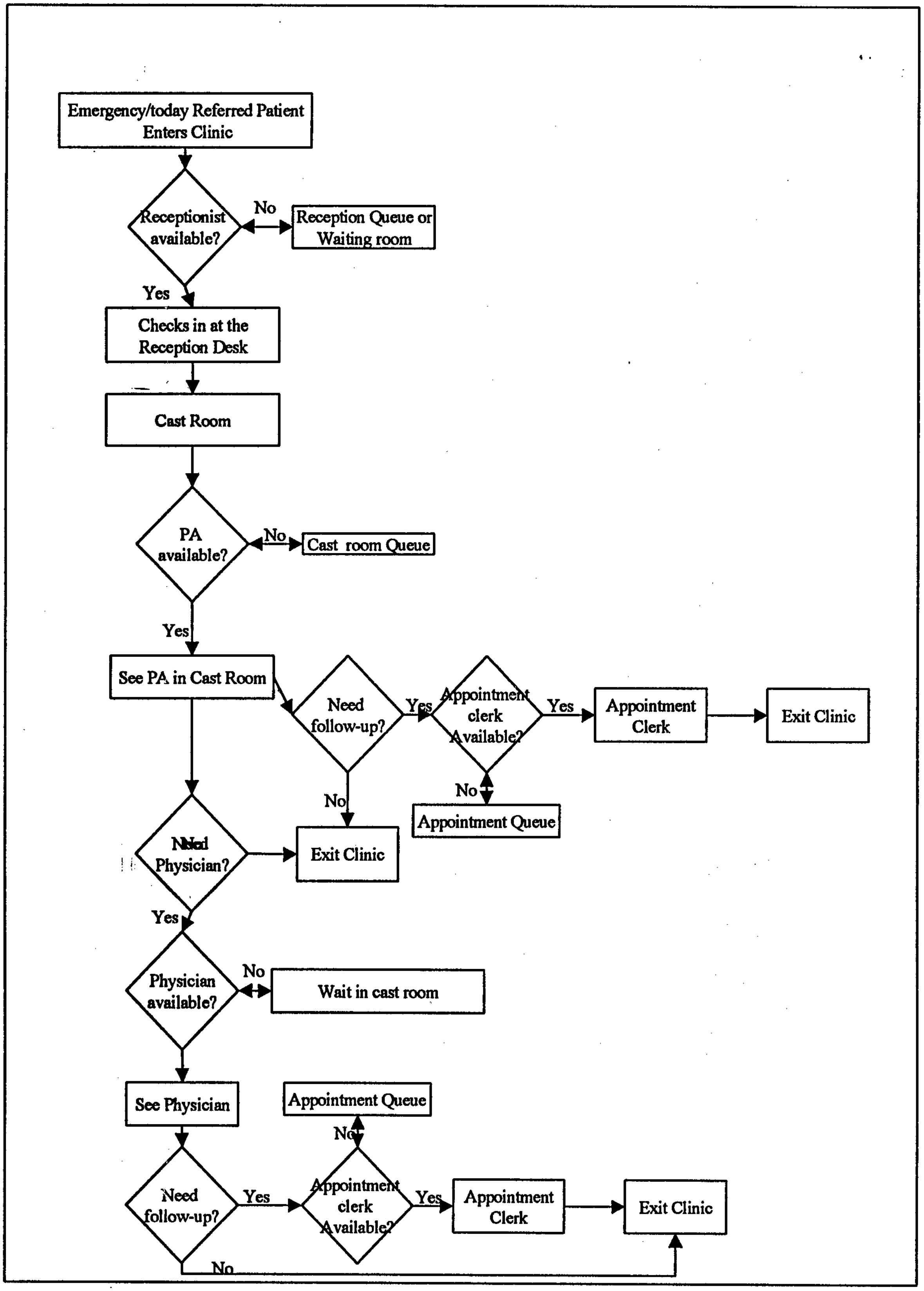
Appendix D (CON-Routine) Flowchart



Appendix E (PHY) Flowchart



Appendix F (CON-Emergency/Today) Flowchart



Appendix G Current orthopedic surgeon appointment templates

Start Time	Appointment Type
730	INP
830	INP
930	NEW
1000	NEW
1030	FOL
1050	FOL
1110	FOL
1130	FOL
1150	POP
1300	NEW
1330	NEW
1400	FOL
1420	FOL
1440	FOL
1500	FOL
1520	FOL
1540	SPC

Start Time	Appointment Type
730	INP
830	INP
915	FOL
940	FOL
1000	FOL
1015	POP
1030	POP
1045	POP
1100	POP
1130	POP
1145	POP
1300	SPC
1330	SPC
1400	SPC
1430	SPC
1500	SPC
1530	SPC

Start Time	Appointment Type
730	INP
830	INP
915	NEW
940	NEW
1005	POP
1015	FOL
1030	FOL
1045	FOL
1100	MEB
1300	NEW
1325	NEW
1400	FOL
1415	FOL
1430	FOL
1445	SPC
1500	MEB

Start Time	Appointment Type
730	INP
815	INP
900	FOL
920	FOL
940	FOL
1000	FOL
1020	FOL
1040	FOL
1100	MEB

Start Time	Appointment Type
1300	FOL
1320	FOL
1340	FOL
1400	FOL
1420	FOL
1440	FOL
1500	MEB

Appendix H Current orthopedic physician assistant appointment templates

Start Time	Appointment Type
730	CON
755	CON
820	CON
845	CON
910	CON
935	CON
1000	CON
1025	CON
1050	CON
1115	CON
1140	CON
1300	FOL
1315	FOL
1330	FOL
1345	FOL
1400	FOL
1415	FOL
1430	FOL
1445	FOL
1500	FOL
1530	FOL
1545	FOL

Start Time	Appointment Type
1000	FOL
1020	FOL
1040	FOL
1100	FOL
1120	FOL
1300	FOL
1320	FOL
1340	FOL
1400	FOL
1420	FOL
1440	FOL
1500	FOL
1520	FOL

Appendix I

BLANCHFIELD ARMY COMMUNITY HOSPITAL
QUALITY SERVICE SURVEY
ORTHOPEDIC CLINIC

Purpose of the survey
The purpose of this survey is to record times spend in various areas of the Orthopedic Clinic at Blanchfield Army Community Hospital. These recorded times will be used in a computer simulation of the clinic designed to decrease patient waiting times.

How to complete the survey
In the shaded area following the questions, please record the time in an hour/minute format (e.g. 8:15 am or 0815). Once completed please return the survey to the reception desk. Thank you.

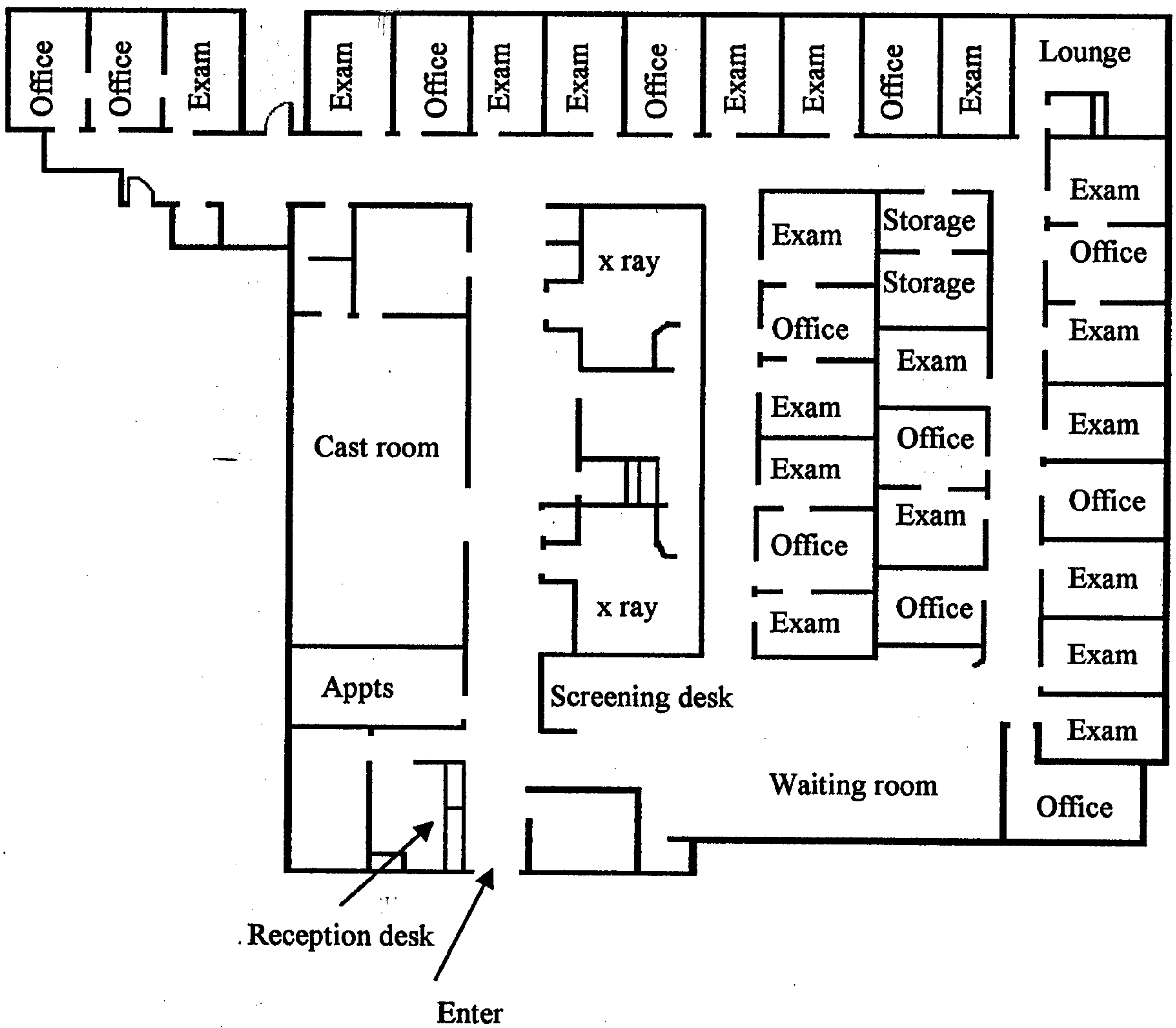
1. Time you entered the Orthopedic Clinic:
2. Time you were seen at the reception desk:
3. Time you left the reception desk:
4. Time you were seen at the screening desk:
5. Time you left the screening desk:
6. When you left the screening desk, where did you go?
(Please answer by placing a ✓ in the appropriate circle or circles)

	First Time Seen	Second Time Seen	Third Time Seen
O Cast room			
Time you signed in at the cast room			
Time you were seen in the cast room			
Time you left the cast room			
O X-Ray			
Time you were seated outside x-ray			
Time you were seen in x-ray			
Time you left x-ray			
O Doctor's Office			
Time you started waiting for a doctor:			
Time you were seen by the doctor:			
Time you left the doctor's office:			

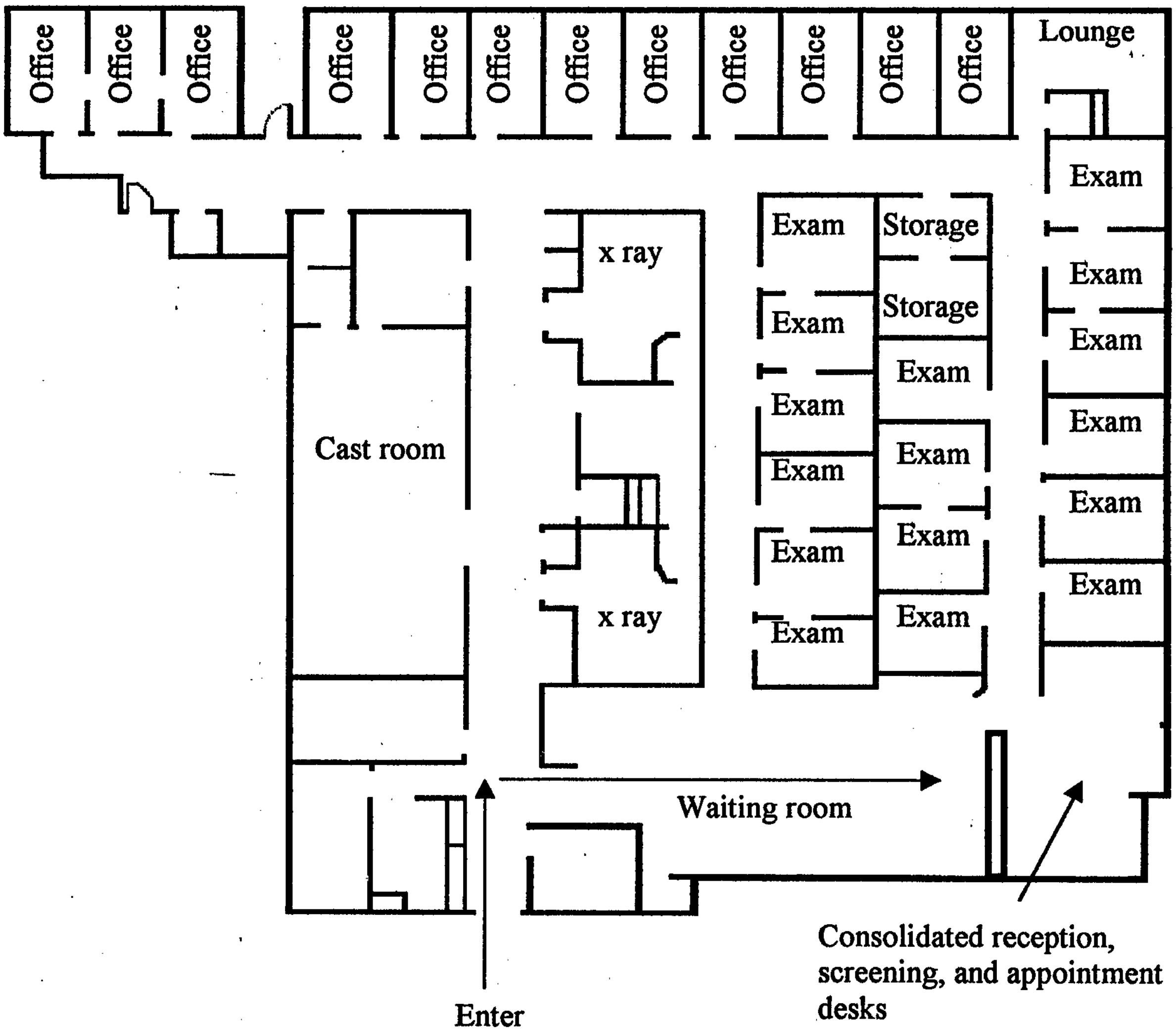
7. Time you arrived at the appointment clerk:
8. Time you exited the clinic:

(For official use only) Appt_____ O FOL O INP O MEB O CON O POP O PHY O BFU O NEW O SPC

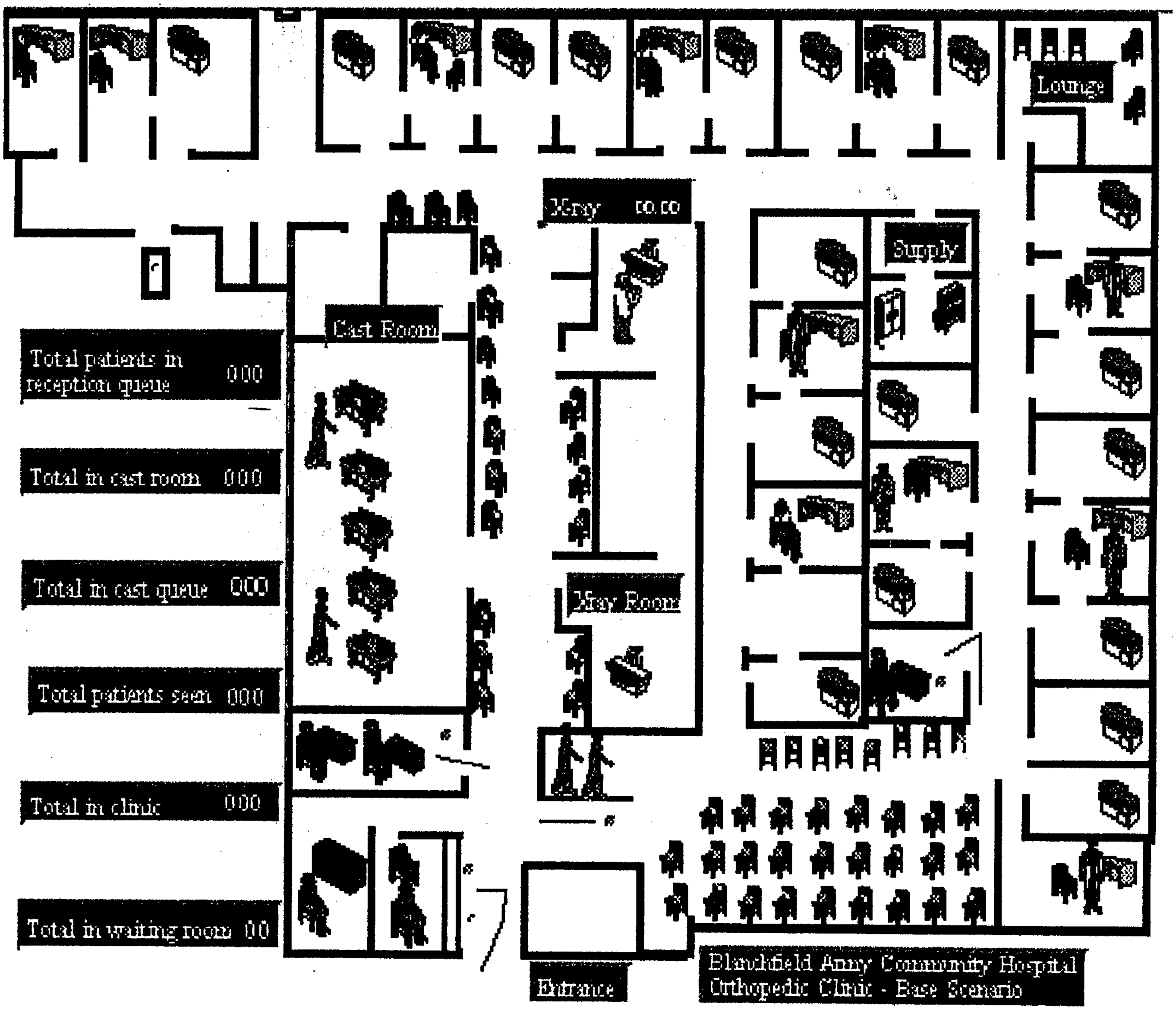
Appendix J Current clinic floor plan



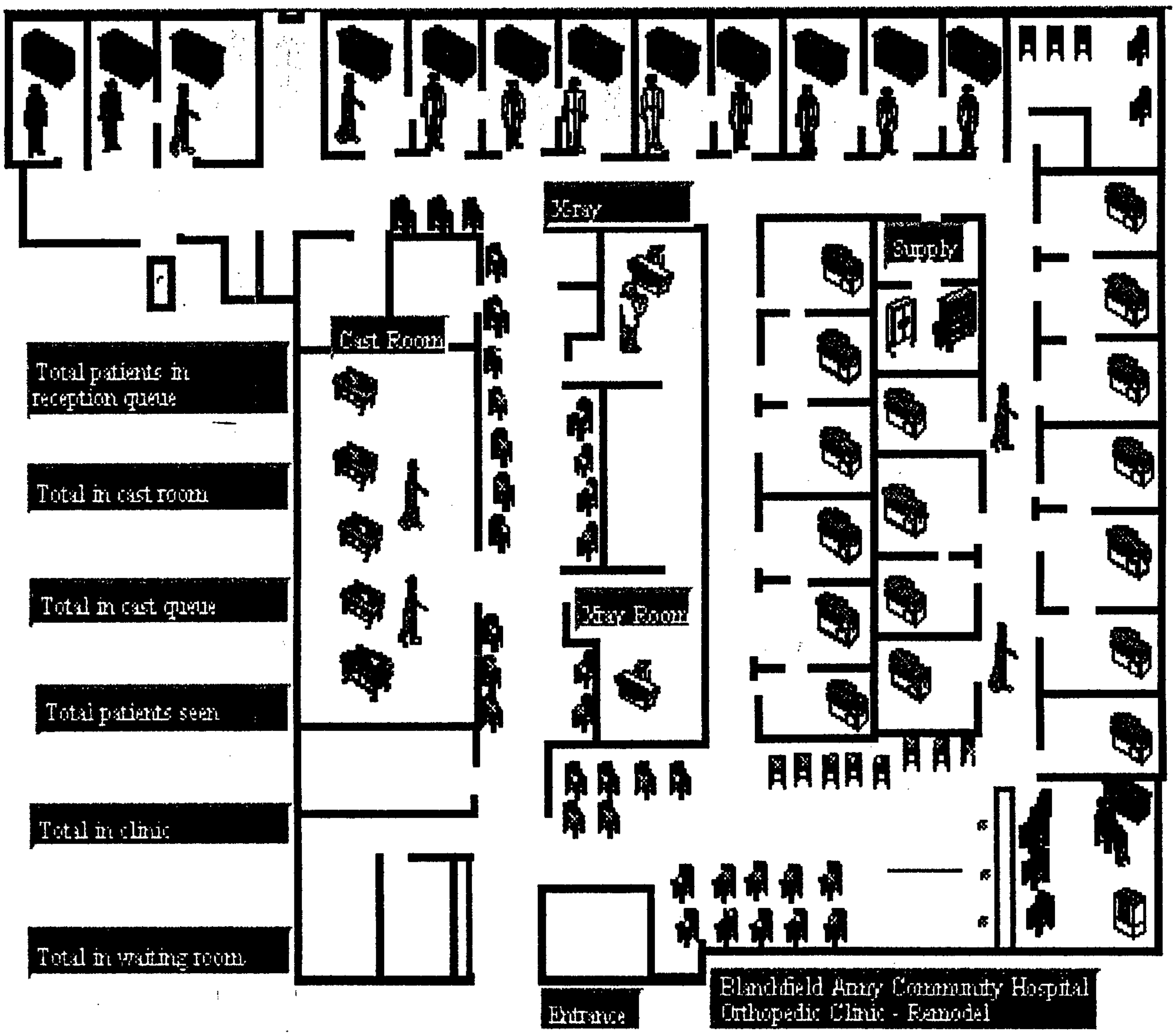
Appendix K Recommended revisions to the clinic floor plan



Appendix L Current clinic floor plan using MedModel



Annex M Recommended changes to the floor plan using Medmodel



Appendix N Simulation scenarios

Aspects of the simulation scenarios involve the manipulation of the resources (clinic's staff), patient arrival patterns, patient care areas, and clinic architecture.

Resources: Resources in the simulation model include orthopedic surgeons, orthopedic physician assistants, orthopedic technicians, orthopedic clerks, one podiatrists, one podiatrist technician, and x-ray technicians.

Patient arrival patterns: The patient arrival patterns were developed from actual patient arrivals during 26-30 Jan 98. Some scenarios involve a new patient arrival template involving a "modified wave" patient arrival concept. The new modified wave templates increased the number of patients seen daily per surgeon from 17 to 25.

Patient care areas: Locations in the simulation include one cast room (5 separate treatment locations), 12 orthopedic surgeon treatment rooms, two orthopedic surgeon physician assistant treatment rooms, one x-ray room, one reception desk, one screening desk, one appointment desk, three podiatry treatment rooms, and one podiatry reception desk.

Clinical architecture: The clinic architecture includes separate reception, screening, appointment, and podiatry reception locations. The architecture effects how the patients flow through the clinic. Some of the simulation models test the effect of consolidating the separate reception areas.

<u>Base model (status quo)</u>
Staffing: Status quo (six orthopedic surgeons, two orthopedic physician assistants, seven orthopedic technicians, four clerks, one podiatrist and one podiatrists assistant)
Patient arrival patterns: Status quo (based on patient arrival data from 26-30 January 1998)
Patient care areas: Status quo
Clinic architecture: Status quo (Separate reception, appointment, and screening locations
Note: The base model is used to simulate actual clinic events and processes. It is compared to observed data and when possible objectively compared to determine the accuracy.

<u>Scenario One</u>
Staffing: increase base scenario staffing by one x-ray technician
Patient arrival patterns: status quo
Patient care areas: increase base scenario by one x-ray room
Clinical architecture: status quo
Note: This scenario tests the effects of adding one full time x-ray technician. It was accomplished in the simulation model by doubling the x-ray room location capacity and doubling the x-ray technician resource.

Scenario Two

Staffing: increase base scenario by one orthopedic surgeon
Patient arrival patterns: status quo
Patient care areas: increase base scenario by one orthopedic surgeon treatment room
Clinical architecture: status quo
Note: This scenario tests the effect of adding one orthopedic surgeon. It was simulated by doubling increasing one surgeon's in-clinic patient schedule (17 patients). Although more patients would be seen, the concern was the increased utilization of the support staff.

Scenario Three

Staffing: increase base scenario by one x-ray technician and one orthopedic surgeon.
Patient arrival patterns: status quo
Patient care areas: increase base scenario by one x-ray room and two orthopedic surgeon treatment room
Clinical architecture: status quo
Note: This scenario tests the effects of increasing the staff. It is simulated by doubling orthopedic surgeon 3 and x-ray tech 1. Concerns are similar to scenario two; the utilization of support staff.

Scenario Four

Staffing: decrease base scenario staffing by one orthopedic surgeon
Patient arrival patterns: status quo
Patient care areas: status quo
Clinical architecture: status quo
Note: This scenario tests the effects of the loss of one orthopedic surgeon. The total number of patients seen would not be reduced and the surgeons remaining in the clinic will absorb the lost surgeon's patient load. Concerns are surgeon utilization and patient total wait times.

Scenario Five

Staffing: status quo
Patient arrival patterns: elimination of no-shows but not walk-ins, increased arrivals to 552.
Patient care areas: status quo
Clinical architecture: status quo
Note: The purpose of this scenario is to test the effects of eliminating the no-shows rate in the clinic while everything else remains constant. Concerns are the staff utilization percentages and patient in clinic wait times. The x-ray usage is predicted to increased proportionally.

Scenario Six

Staffing: status quo
Patient arrival patterns: new scheduled system, patients arrive in waves
Patient care areas: status quo
Clinical architecture: status quo
Note: The purpose of this scenario is to test a new schedule system where the patients arrive in a modified wave. The orthopedic surgeon's treatment time on POPs and MEBs are decreased by approximately 2-3 minutes per patient. The x-ray utilization is predicted based on current data.

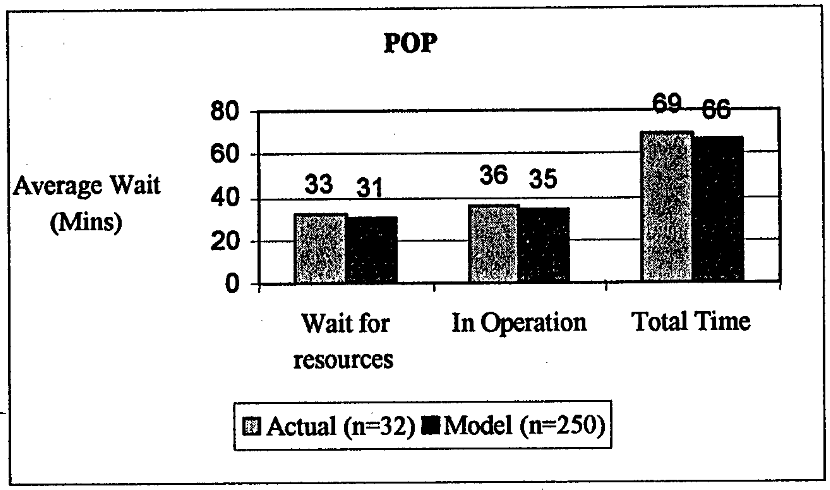
<u>Scenario Seven</u>
Staffing: status quo
Patient arrival patterns: new scheduling system, patients arriving in waves, and 10% no shows
Patient care areas: status quo
Clinical architecture: status quo
Note: The purpose of this scenario is to test the modified wave appointment system with a realistic 10% no show rate.

<u>Scenario Eight</u>
Staffing: status quo
Patient arrival patterns: status quo
Patient care areas: status quo
Clinical architecture: clinic redesign (consolidation of reception, screening, appointment and podiatry reception desks to one location).
Note: This scenario tests the effects of clinic architectural redesign. Patient flow will change from a patient potentially stopping at five separate clinic locations to one.

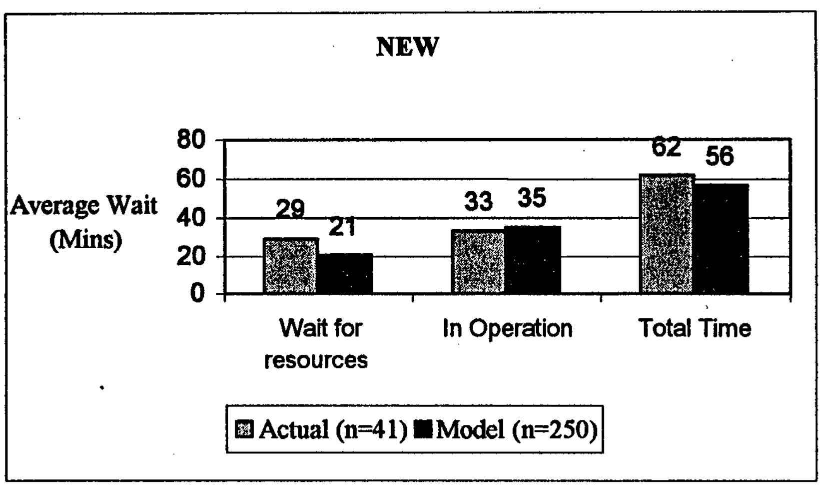
<u>Scenario Nine</u>
Staffing: increase base scenario by one x-ray technician and one orthopedic surgeon
Patient arrival patterns: new schedule
Patient care areas: increase base scenario by one x-ray room and one orthopedic surgeon treatment room
Clinical architecture: clinic redesign (consolidation of reception, screening, appointment and podiatry reception desks to one location).
Note: This scenario tests the combined effect of additional staff and clinic redesign.

<u>Scenario Ten</u>
Staffing: changing responsibilities of the orthopedic technicians, increase base scenario by one x-ray technician
Patient arrival patterns: even distribution of arrivals (changing current scheduling system and reducing walk-in patients
Patient care areas: increase base scenario by one x-ray room
Clinical architecture: clinic redesign (consolidation of reception, screening, appointment and podiatry reception desks to one locations).
Note: This scenario includes all proposed changes with the exception of adding an additional orthopedic surgeon. An important aspect of this scenario is that each orthopedic technician is assigned to work with a specific physician.

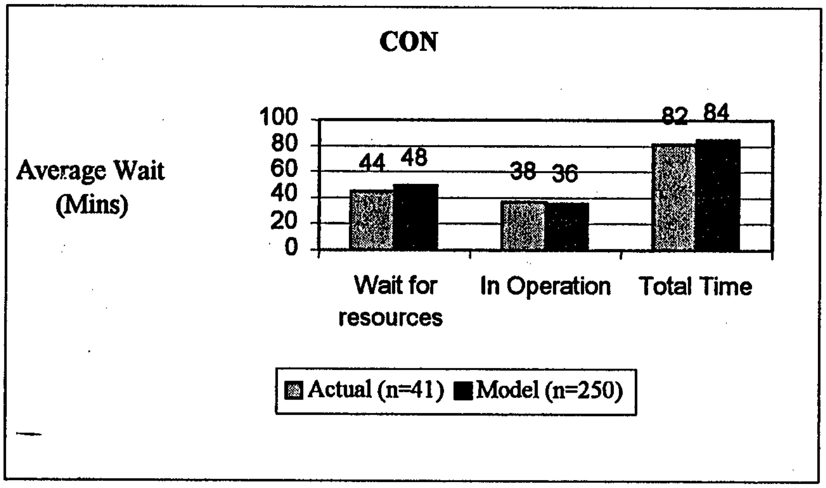
Appendix O Subjective validation of the base model



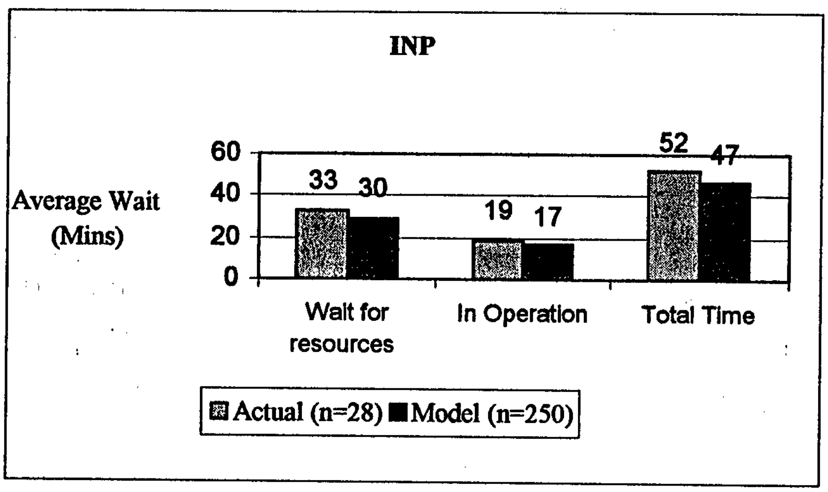
Note. The data source for "Actual" column was obtained from patient surveys. The "Model" column data are the results of the base model simulation.



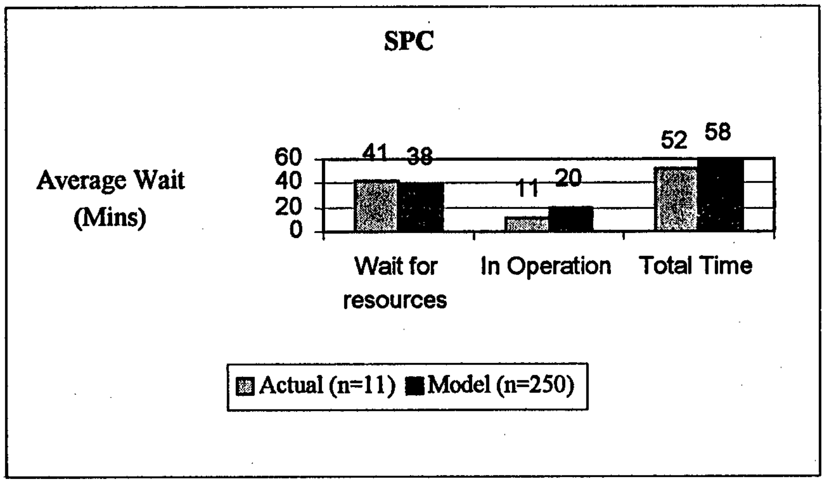
Note. The data source for "Actual" column was obtained from patient surveys. The "Model" column data are the results of the base model simulation.



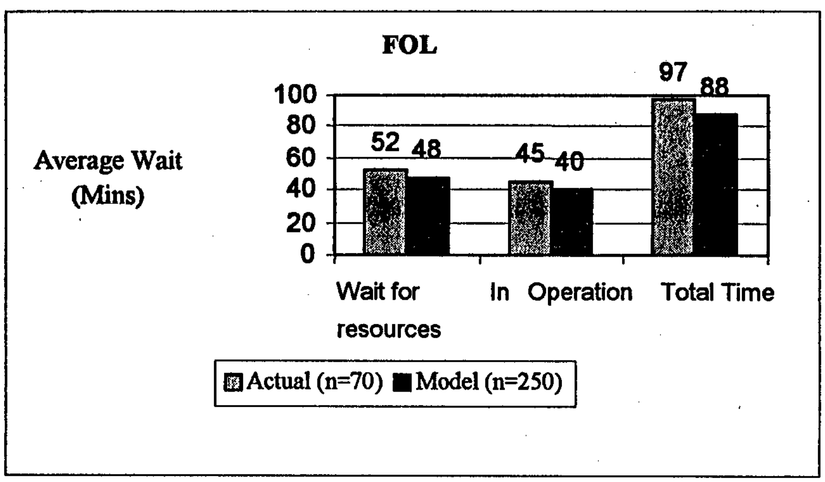
Note. The data source for "Actual" column was obtained from patient surveys. The "Model" column data are the results of the base model simulation.



Note. The data source for "Actual" column was obtained from patient surveys. The "Model" column data are the results of the base model simulation.



Note. The data source for "Actual" column was obtained from patient surveys. The "Model" column data are the results of the base model simulation.



Note. The data source for "Actual" column was obtained from patient surveys. The "Model" column data are the results of the base model simulation.

Appendix P ANOVA results for scenarios 1-10

Variable		Sum of Squares	df	Mean Square	F	Sig
Total time in clinic	Between Groups	2217871	9	443574	78.597	.001
	Within groups	1.7E+07	2978			
	Total	1.9E+07	2983			

Appendix Q Orthopedic Clinic emergency room referral scheduling sheet

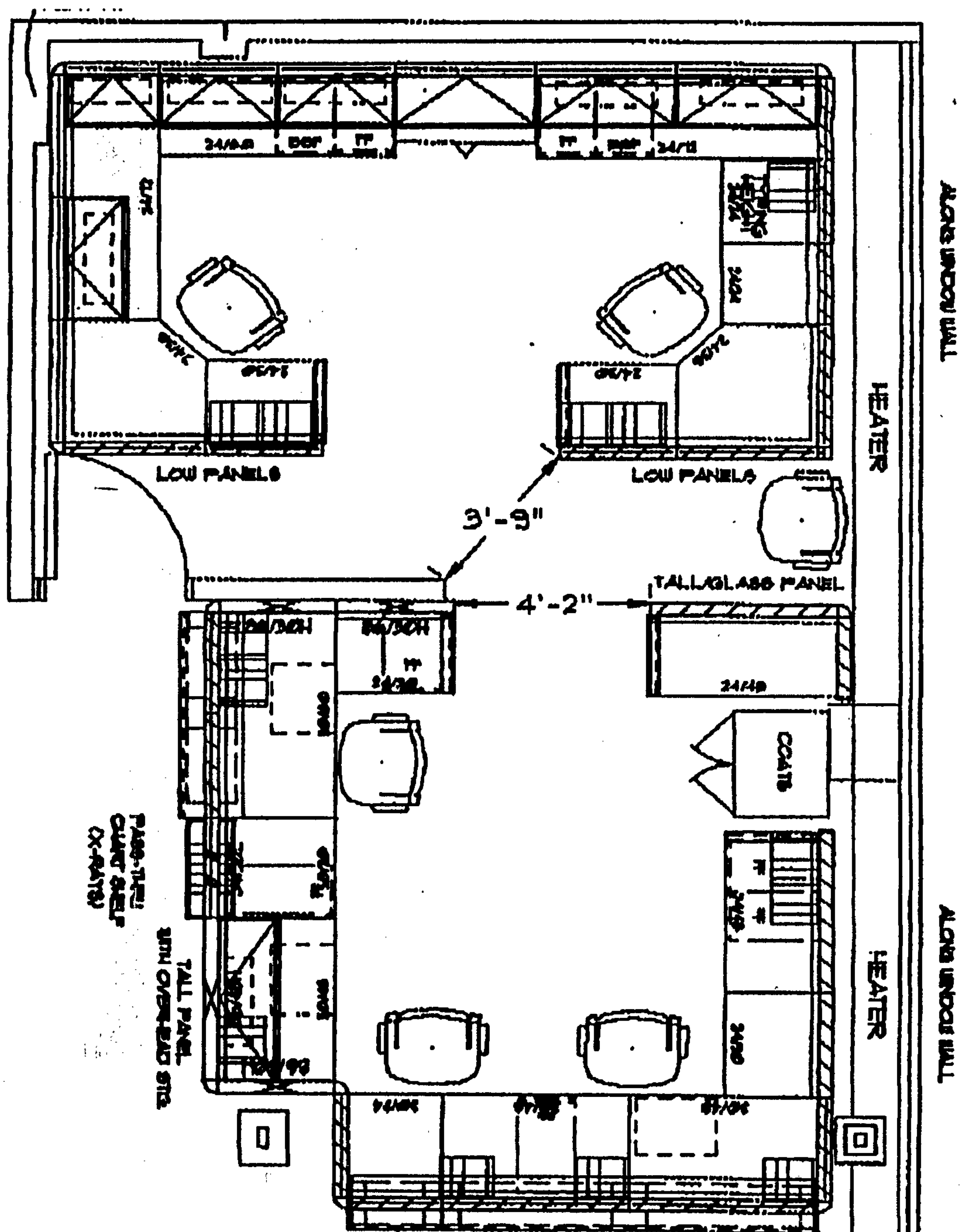
ORTHOPEDIC EMERGENCY ROOM REFERRALS

(Patients being referred to the Orthopedic Clinic that are seen in the Emergency Center)

DATE ______________

Appt Time	1st Slot Name	SSN	2nd Slot Name	SSN
0730				
0745				
0800				
0815				
0830				
0845				
0900				
0915				
0930				
0945				
1000				
1015				
1030				
1045				
1100				
1115				
1130				
1145				
1300				
1315				
1330				
1345				
1400				
1415				
1430				
1445				
1500				
1515				
1530				

Appendix R Architectural blueprints of central reception/business office



Appendix S Revised templates

Appointment Time	Appointment Type
730	FOL
	PREOP
0815	NWR
	FOL
0845	FOL
	FOL
0915	PREOP
1000	NWR
	NWR
1045	FOL
	FOL
1115	FOL
1245	NWR
	POP
1315	NWR
	FOL
1345	FOL
	FOL
1420	NWR
	FOL
1450	NWR
1510	MEB

Note. This is an example of the revised templates. The appointment types have been changed to meet the TRICARE contractor standard. The templates can be altered to address the individual needs of each surgeon.

Appendix T Presentation to the hospital commander and staff

Determining the Optimal Operational Concept in the Orthopedic Clinic

MedModel

MAJ William B. Grimes
Administrative Resident

Agenda

- Problem Statement
- Methodology
- Background
- Literature Review
- Simulation
- Recommendation
- Conclusion

Problem Statement

- Perceived inefficiencies
  - Access standards
  - Appointment systems
    - Provider templates
    - Walk-in to appointment ratios
- Meeting TRICARE access standards
  - Currently not meeting access standards for specialty visit (four weeks)
  - Currently not meeting in-clinic waiting times (thirty minutes)

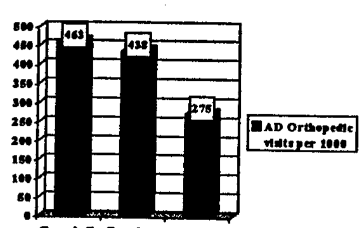
Methodology

- Determined and measured variables
  - Patient treatment and wait times
  - Patient flow
- Studied the system
- Conducted changes via simulation
- Re-measured the variables and predicted changes

Background

- Previous study conducted in 1995
  - Choke points in patient movement
  - Time consuming MEBs
  - Walk-in to appointment ratio
  - Recommendations not implemented
- Fort Campbell's Active Duty (AD) population maintains a high incidence of orthopedic injuries

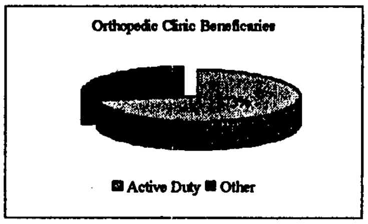
Active Duty Utilization



Note: Data source DMIS and World Wide Report Generated by PASBA

Orthopedic Clinic

Beneficiary Category



Data Source: ADS Jan 97-Dec97

Provider Backlogs

Orthopedic Surgeon Clinical Appointment Backlog

Provider	Clinic Appointment Backlog	Number of Patients
Orthopedic Surgeon 1	6 weeks	161
Orthopedic Surgeon 2	4 weeks	148
Orthopedic Surgeon 3	5 weeks	103
Orthopedic Surgeon 4	2 weeks	42
Orthopedic Surgeon 5	1 week	27
Orthopedic Surgeon 6	1 week	22

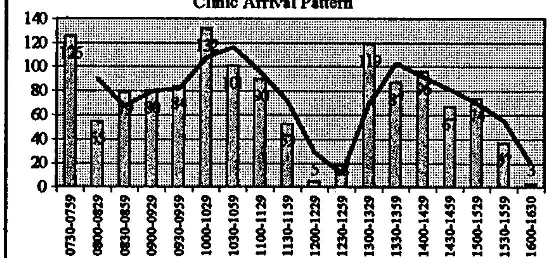
Note. The source for the data is CHCS, clinic code BEAA.

Literature Review

- Computer simulation is an effective tool
  - Staffing ratios
  - Patients movement
  - Fairly inexpensive method of conducting what if scenario analysis
- Clinic efficiency is a function of
  - Arrival patterns (templates/walk-ins)
  - Patient flow (identification of choke points)
  - Staffing ratios

Orthopedic Clinic

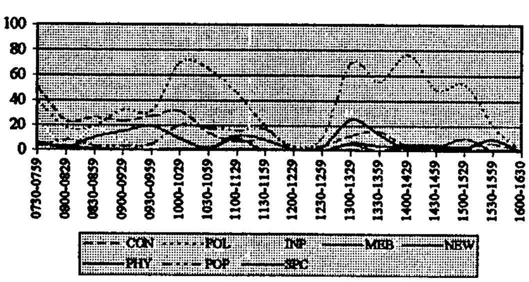
Clinic Arrival Pattern



Data Source: CHCS Oct 97-Nov 97

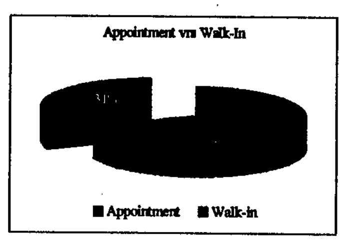
Orthopedic Clinic

Clinic Arrival Pattern by CHCS Appointment Type



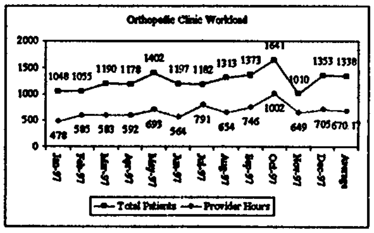
Orthopedic Clinic

Appointment System



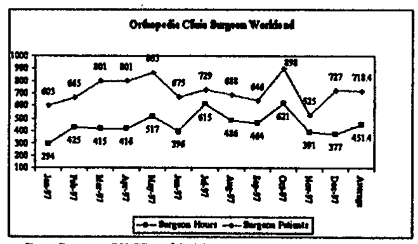
Data Source: CHCS Jan 97-Dec 97

Orthopedic Clinic



Data Source: CHCS and MEPRS

Orthopedic Clinic



Data Source: CHCS and MEPRS

Orthopedic Clinic

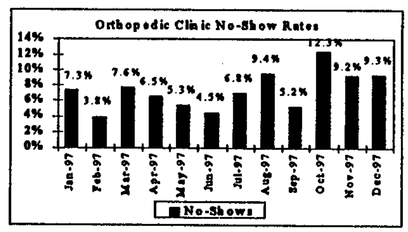
Orthopedic Surgeon Efficiency

Surgeon	Average In Clinic Hours	Average Patients Seen	Pts/Hour	AHA Standard Pts/Hour
Surgeon 1	62	85	1.37	3.44
Surgeon 2	97	174	1.79	3.44
Surgeon 3	110	119	1.09	3.44
Surgeon 4	101	128	1.26	3.44
Surgeon 5	95	113	1.18	3.44
Surgeon 6	82	117	1.41	3.44

Note. Data Source MEPRS, CHCS reports

Note: Templated for see 17 patients a day, effected by no-shows, MEBs, staffing levels, inaccurate reporting of MEPRS data.

Orthopedic Clinic



Data Source: CHCS Jan 97 - Dec 97

Orthopedic Clinic

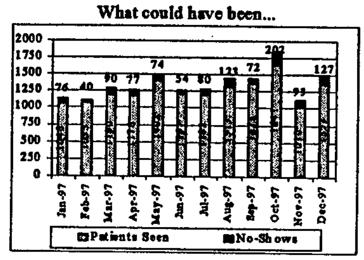
Related Major Unit Training Exercises

Major Training Deployments	Dates	Size
JRTC 97-03	Jan 97	1 BDE
JRTC 97-05	Mar 97	1 BDE
JRTC 97-06	Apr 97	1 BDE
NTC 98-02	Oct-Nov 97	2 BDEs

Data Source: MTEAM, Division Training Calendar

Orthopedic Clinic

What could have been...

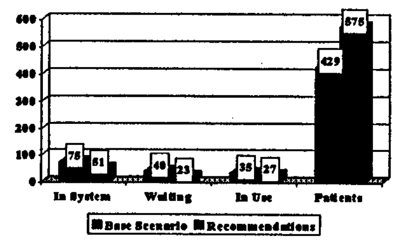


Data Source: CHCS Jan 97- Dec 97

Simulation scenarios

- 13 different scenarios
- Manipulated variables:
  - Staffing ratios
    - Utilization
  - Patient arrival patterns
    - Templates
  - Patient flow
  - Clinic architecture
- Demonstration

Simulation Comparison



Recommendations Validated by Simulation

- Arrival patterns
  - Individualized provider templates
  - Schedule walk-ins when possible
  - Reducing no-show rates increases utilization
- Patient flow
  - Consolidate reception and screening locations
- Staff
  - Dedicate orthopedic technician to a surgeon
  - Remove the orthopedic technician working at reception
  - Additional xray technician

Other Recommendations

- Staff
  - Do not answer phones at front desk
  - Cross train all clerks
  - Additional training on CHCS
- Patient appointment system
  - Pre-register patients scheduled to return to the clinic
    - Pre-order xrays
- Reduce no-show
  - Computerized patient reminder system
  - Observe Division training calendar
  - Possible email reminders/appointment scheduling

Other Recommendations

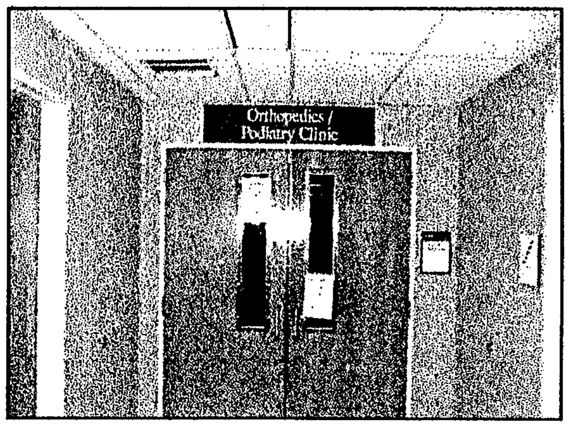
- Leadership
  - Active clinic management
    - Move NCOIC's office adjacent to reception area
  - Continued tracking of efficiency indicators used in the study
  - Develop clinic goals and objectives
    - Further study to set goals for unbooked appointments and no-show rates
- "Out of the Box"
  - Army MTF wide Orthopedic Service VTC

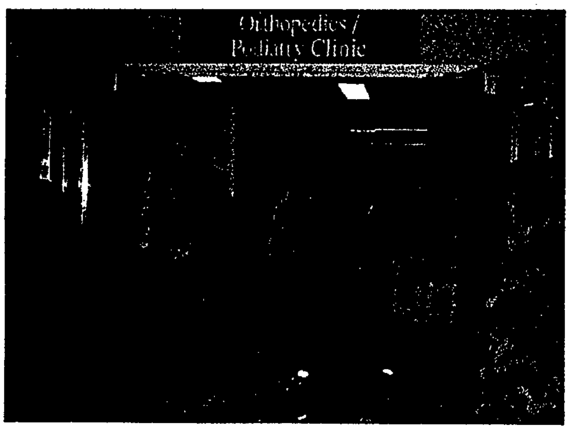
Other Recommendations

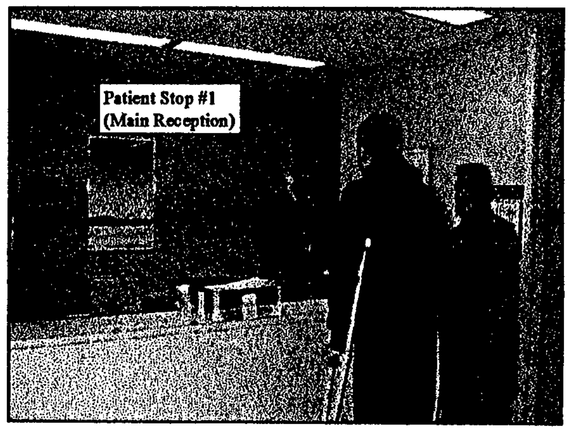
- Further study
  - Expanding the roles of the orthopedic technicians
  - Follow-up study
    - Re-measure efficiency indicators after changes

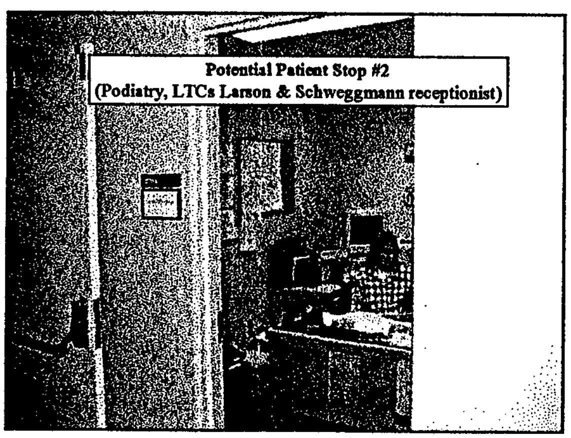
Conclusion

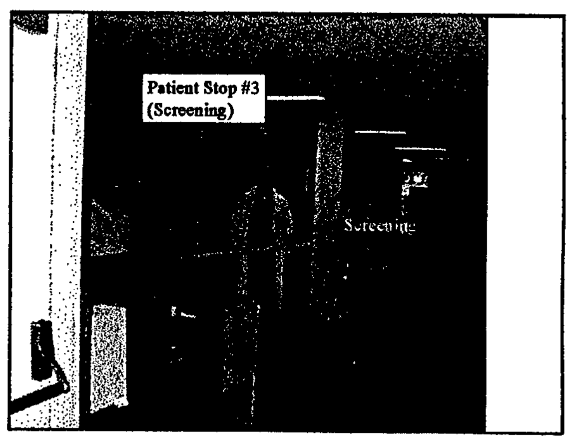
- Simulation is effective method for analyzing efficiency and should be continued
- Problems identified are similar to the 1995 study
- Implementing recommendations should:
  - Meet TRICARE standards (access/wait times)
  - Improve patient satisfaction
  - Reduce provider backlogs

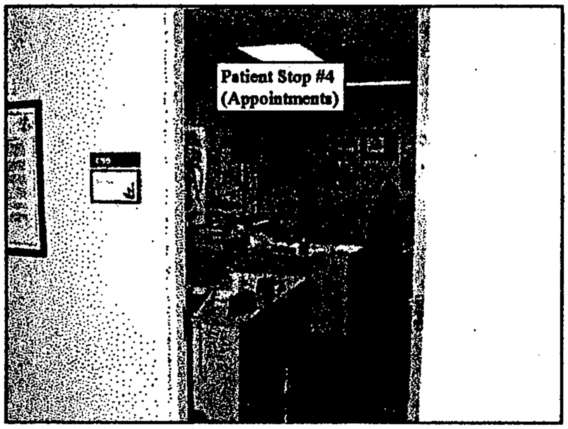


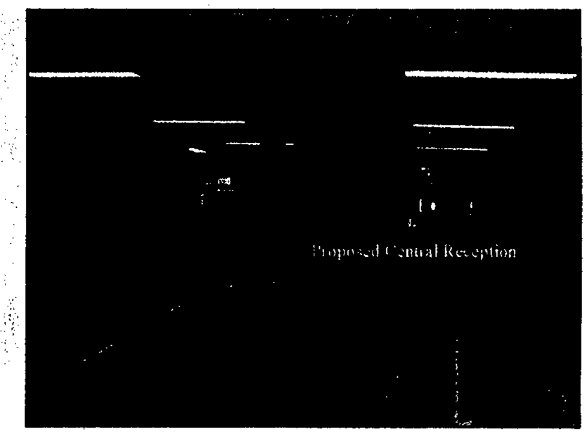









Patient Stop #4
(Appointments)


Proposed Central Reception